PIEDMONT AIRLINES

MAINTENANCE TRAINING MANUAL

SERIAL NO. 228

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NAME C. W. Burton STATION ILM

POSITION ____________________

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Chapter 1 INTRODUCTION

1.1 General

The YS-11 is an all metal, low wing, monoplane with a wing and tail of cantilever, stressed skin construction and a fuselage with circular section of stressed skin construction.

In the L.H. and R.H. wing nacelles are installed 2 Rolls Royce Dart Mark 542-10 turboprop engines.

1.2 Summary

Structurally the fuselage consists of 3 parts; forward, center and aft sections.

The fuselage is pressurized all the time during flight and at 20,000 ft of flight altitude, the cabin altitude is maintained at 8,000 ft.

The fuselage is divided into 2 parts; the above-floor space and the under-floor space by aluminum honeycomb floor. Above the floor are located the cockpit, cabin, galley, toilet and cargo compartment. The space below the floor is occupied by the nose gear compartment, electrical compartment, belly cargo compartment, flight control compartment, hydraulic compartment and air conditioning compartment.

The crew consists of 5, the pilot, copilot, observer and 2 stewardesses and the cabin arrangement provides 60 passenger seats.

The wing consists of the center wing and the L.H. and R.H outer wings, the former being joined to the center fuselage permanently and the latter joined to the center wing with bolts.

Outboard the nacelle, between the spars in the outer wing is located the integral fuel tank and inboard the nacelle are the water methanol bag tank and the fuel bag tank.

The landing gear mechanism is of nose gear type, fully retractable with the nose gear hydraulically steerable and the main gear with the anti-skid mechanism.

The 3 flight control surfaces are manually controlled by the pilot or the copilot.

The flap is of Fowler type, actuated by a hydraulic motor through a torque tube.

The engines and the propellers are electrically deiced and deicers of rubber boots type are installed on the leading edges of the wing and the tail.

The hydraulic pressure of 3,000 psi is used to actuate the landing gear, brake steering etc. As for fire extinguishing device, fire in each engine, deicing heater, landing gear bay or nacelle can be extinguished separately.

The electronic equipment includes communication units such as HF and VHF and navigation units such as VOR, LOC, G/S, Marker etc. Provision is also made for installing the weather radar and auto-pilot mechanism.

DC, constant frequency AC and wild frequency AC power sources are utilized to activate the above-mentioned systems.

1.3 Operation

The YS-11 can be operated within the operating temperature limitation; -50°C to ISA + 30°C of the outside air temperature except the following:

1. Water methanol injection permissible above -20°C.
2. External power starting permissible above -30°C.
3. Internal power starting permissible above -10°C.

1.4 Leading Particulars

1.4.1 Weights

The breakdown of the take-off gross weight under a typical loading condition is given below:

		LB (Kg)	LB (Kg)
Weight Empty			31,970 (14,500)
Additional Equipment			550 (249)
Crew	Pilots (2)	340 (154)	
	Stewardesses (2)	260 (118)	
	Baggage	60 (27)	
		660 (299)	660 (299)
Operational Weight			33,180 (15,050)
Payload			15,320 (6,950)
	Passengers (160x60)	9,000 (4,080)	
	Cargo	4,300 (1,945)	
	Additional Load	2,020 (925)	
		15,320 (6,950)	
Zero Fuel Weight			48,500 (22,000)
	Oil		84 (38)
	Fuel		4,875 (2,212)
	Water Methanol		551 (250)
Take-off Weight			54,010 (24,500)

1.4.2 Breakdown of Empty Weight (Reference to Your Type Spec)

The calculated breakdown of the empty weight is given below(at YS-11):

Airframe Structure	LB(Kg)
Wing	6,618 (3,002)
Tail	1,465 (664)
Fuselage	5,525 (2,506)
Landing Gear	2,110 (957)
Nacelles	1,541 (699)
Total	17,257 (7,828)
Power Plant	6,184 (2,805)
Basic Equipment	
Instrument System	205 (93)
Flight Control System	719 (326)
Hydraulic System	602 (273)
Electrical System	1,863 (845)
Electronic System	1,039 (472)
Interior Equipment	3,029 (1,374)
Air Conditioning System	776 (352)
Deicing System	357 (162)
Oxygen System	31 (14)
Fire Extinguishing System	97 (44)
Stairway	315 (143)
Total	9,033 (4,098)
Miscellaneous	
Paint and Exterior Marking	77 (35)
Undrainable Oil	40 (18)
Unusable Fuel	220 (98)
Total	337 (151)
Empty Weight	32,811(14,882)

1.4.3 Operating Limitations

Weight Limitation	YS-11	YS-11A
Maximum Take-off Weight	51,800(23,500)	54,010(24,500)
Maximum Landing Weight	49,600(22,500)	52,910(24,000)
Maximum Zero Fuel Weight	45,640(20,700)	48,500(22,000)

C.G. Limitation
With flap 0° and landing gear down

Weight LB(Kg)	Most Forward % MAC	Most Rearward % MAC
35,270 (16,000)	15	36
54,010 (24,500)	22.4	36

1.4.9 General Data

Wing

Wing Span	104' 11.8" (32.000 m)
Wing Chord (root)	13' 9.4" (4.200 m)
" (tip)	4' 11.1" (1.500 m)
" (MAC)	10' 6.1" (3.204 m)
Airfoil (root)	NACA 64A218a = 0.8
" (tip)	NACA 64A412a = 0.8
Angle of Attack (root)	3°
" (tip)	0°
Dihedral	6°19'
Aspect Ratio	10.8
Taper Ratio	0.336

Tail (Horizontal)

Wing Span	39' 4.4" (12.000 m)
Wing Chord (root)	8' 2.4" (2.500 m)
" (tip)	3' 3.4" (1.000 m)
Airfoil (root)	NACA 63A014
" (tip)	NACA 63A012
Angle of Attack	0°
Dihedral	0°
Aspect Ratio	6.5
Taper Ratio	0.349

Tail (Vertical)

Height	15' 1.1" (4.600 m)
Wing Chord (root)	14' 9.2" (4.500 m)
" (tip)	6' 6.7" (2.000 m)
Airfoil (root)	NACA 63A012
" (tip)	NACA 63A012
Aspect Ratio	1.5
Taper Ratio	0.419

Fuselage

Length	86' 3.4" (26.300 m)
Maximum Diameter (Outer)	9' 5.4" (2.800 m)

Landing Gear

Wheel Size (Main)	12.50 - 16	
" (Nose)	24 x 7.7	
Tire Size and Pressure (Main)	12.50 - 16	75 psi
" " (Nose)	24 x 7.7	50 psi
Wheel Base	31' 2.6" (9.515 m)	
Tread	28' 2.6" (8.600 m)	
Maximum Oleo Stroke (Main)	1' 2.2" (0.360 m)	
" " (Nose)	1' 1.1" (0.330 m)	

Cargo Compartment Volume

	Cargo Compartment Volume cu.ft (m^3)		
	52 seats 38" pitch	52 seats 34" pitch	60 seats 34" pitch
Forward Cargo Comp't (R/H)	116 (3.28)	176 (4.97)	94 (2.66)
Forward Cargo Comp't (L/H)	-	82 (2.31)	-
Aft Cargo Comp't	171 (4.84)	171 (4.84)	171 (4.84)
Belly Cargo Comp't	70 (1.98)	171 (4.84)	171 (4.84)
	357(10.10)	499(14.10)	335 (9.48)

Engine Data

Reduction Ratio	0.0775
Direction of Rotation	Engine ..... Clockwise viewed from rear Propeller... Counterclockwise viewed from rear
Engine Performance	Average Rating at Sea Level, standard atmospheric conditions

	Speed rpm	Shaft Horse Power HP	Jet Thrust LBS(Kg)	Equivalent Shaft Horse power HP	Specific Fuel Consumption LBS/Hr (Kg/Hr)
Take-off (with W/M injection)	15,000	2,775	740(336)	3,060	-
Take-off (without W/M injection)	15,000	2,400	660(299)	2,660	0.708(0.321)
Maximum Continuous	15,000	2,400	660(299)	2,660	0.708(0.321)
Maximum Cruising	14,200	1,880	525(238)	2,080	0.760(0.345)

Propeller Data

Diameter	14'6" (4.420m)
Pitch	0° to 84°15'

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Chapter 2 STRUCTURE

2.1 Construction -- Description

2.1.1 General

The YS-11 described herein has stressed-skin structure. Metallic materials used in the YS-11 are mainly aluminium alloys 2024 and 7075, all sheet metal used for structure being alclad. All other metallic components are surface-treated.

The rivets and screws exposed on the skin surface, except those for the elevators, rudder, flaps and tail cone, are mostly those with flush heads. The access doors are provided flush with the skin.

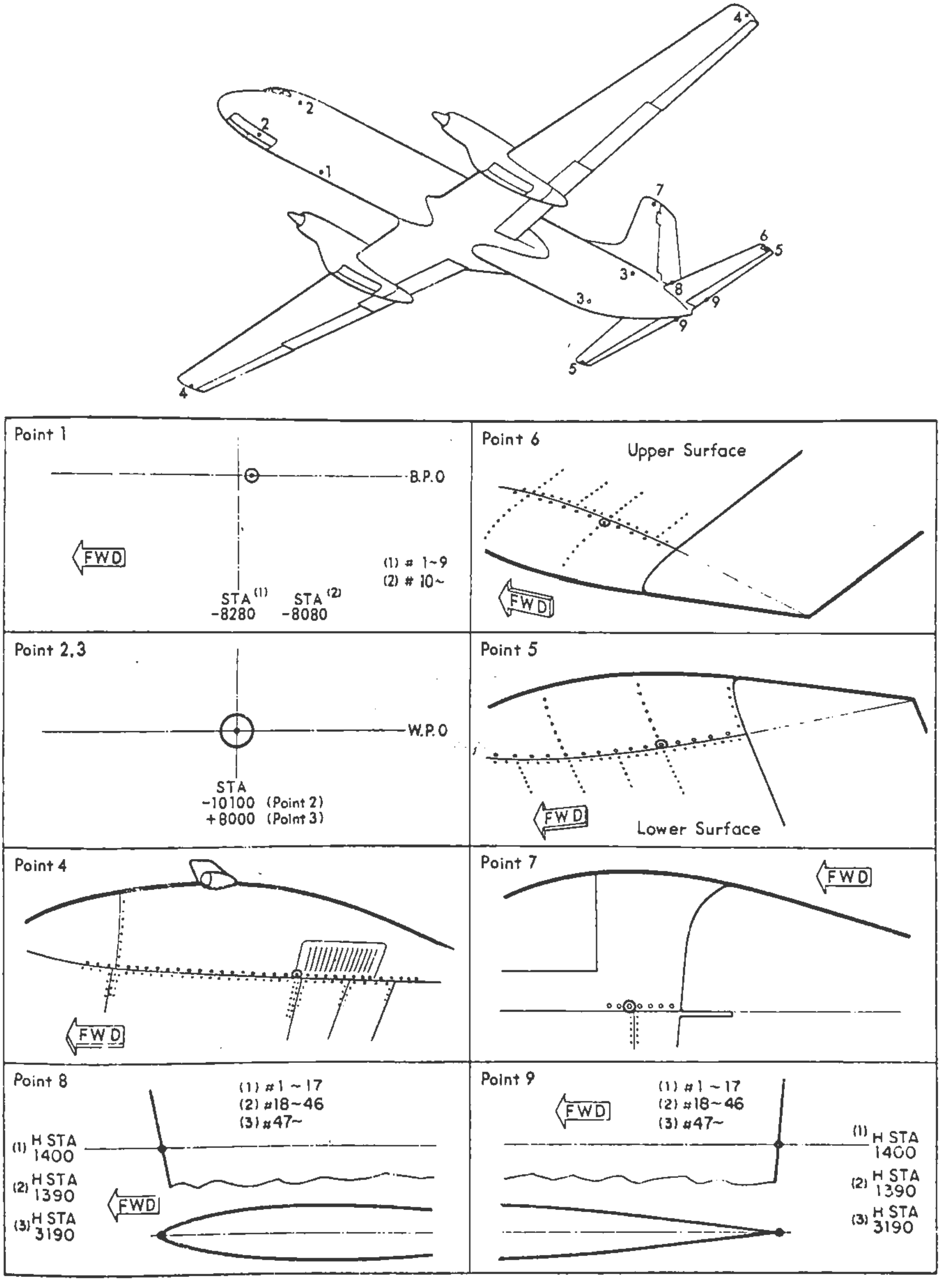
Hermetically closed structural sections are ventilated, drained, and protected from rain water as necessary. Each of these sections has an access door for easy access to the interior for inspection.

2.1.2 Station Diagram

The airframe structure is provided with station numbers which are shown in Fig. 2-1.

2.1.3 Alignment

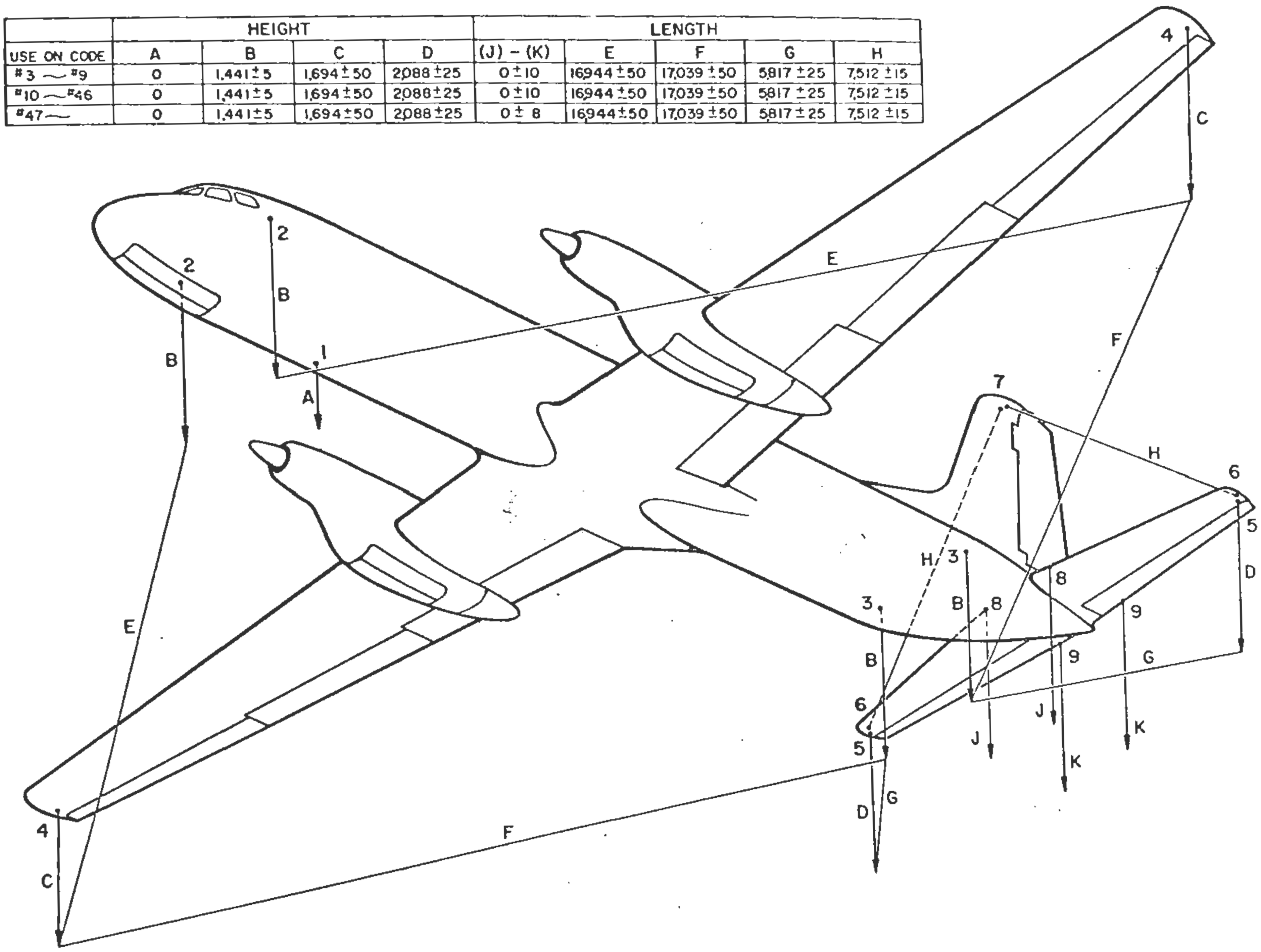
Fig. 2-3 shows the alignment check points of the airframe structure and their numbers.



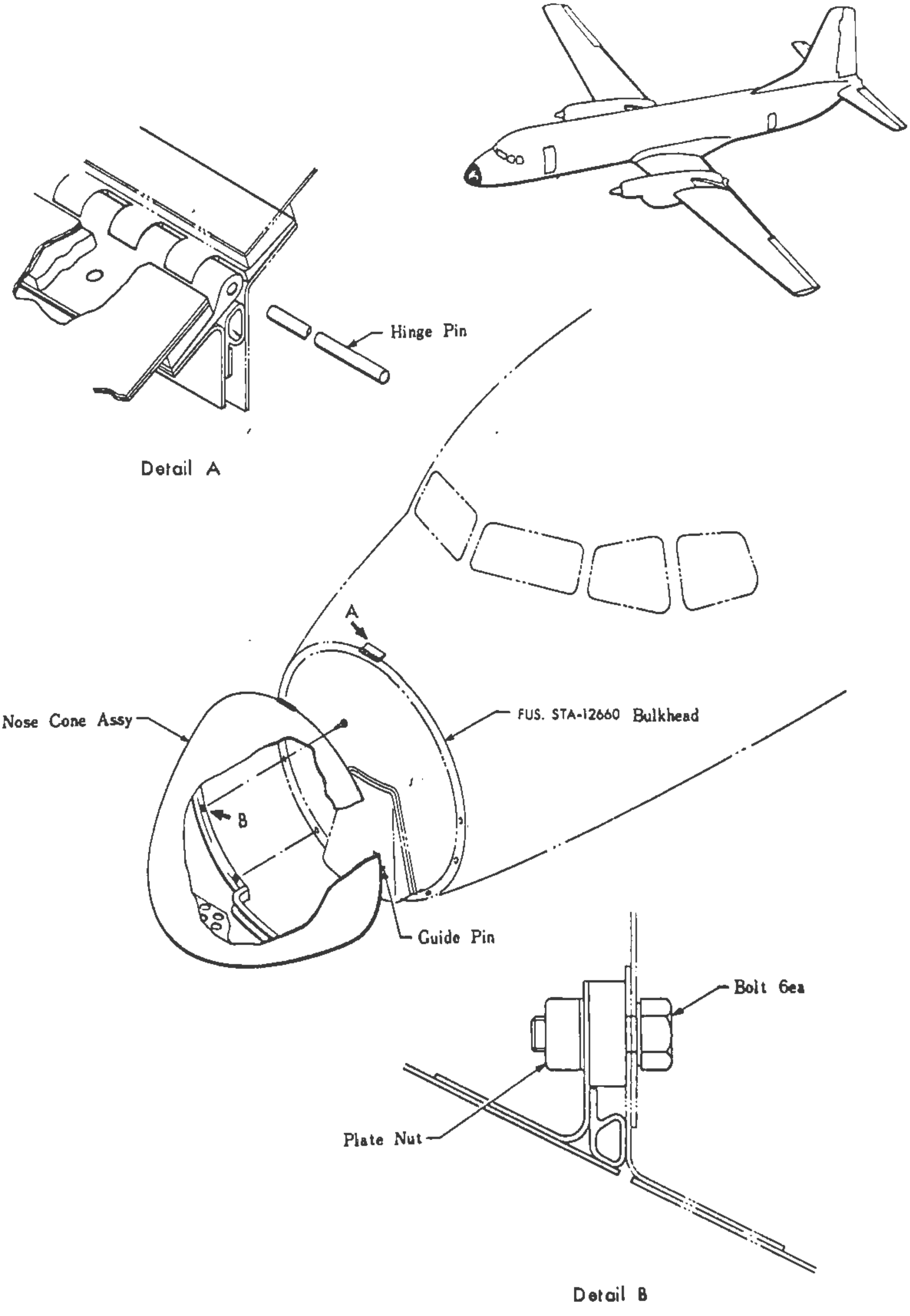
Alignment Point

Figure 2-2

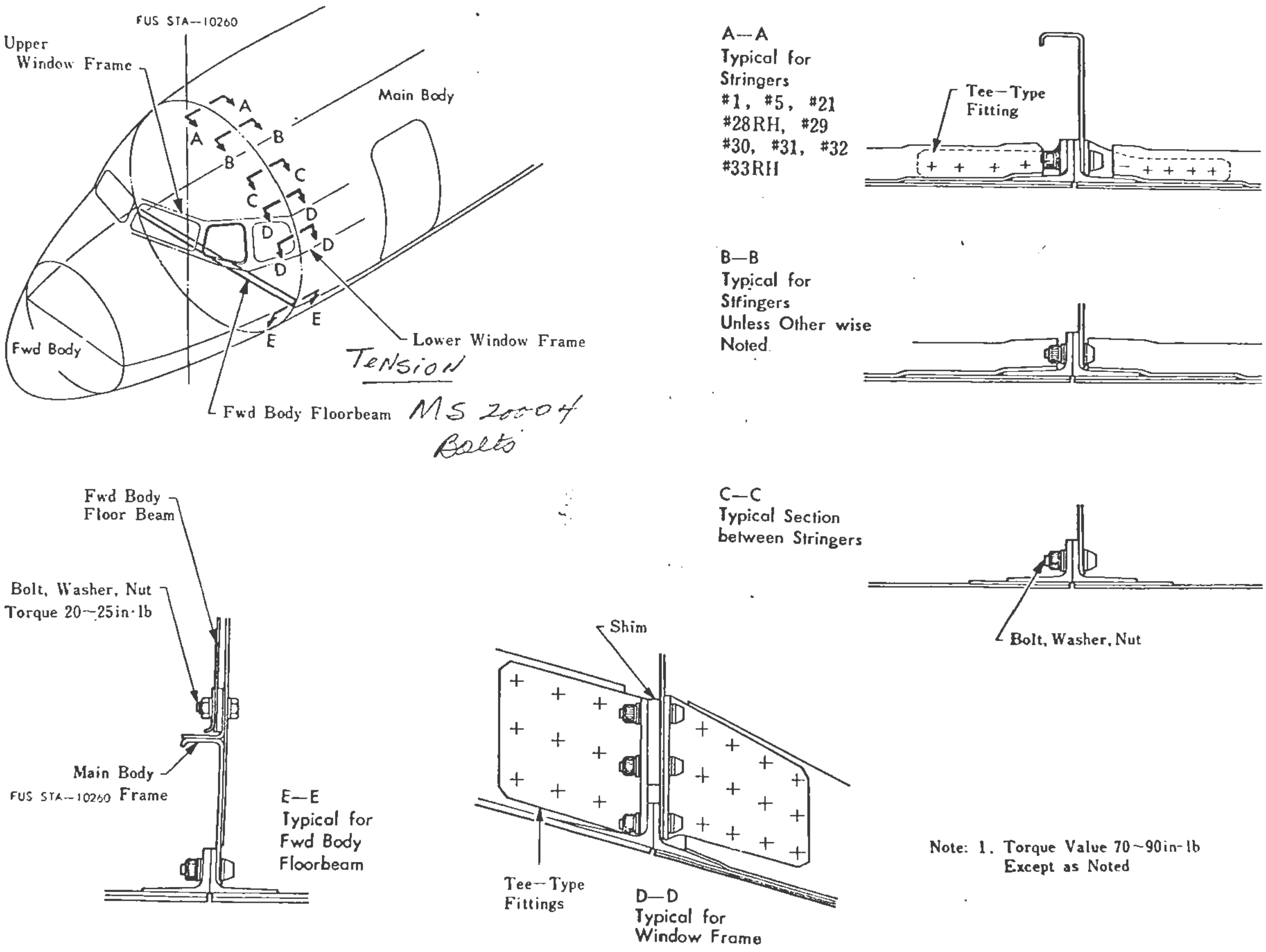
	HEIGHT				LENGTH				
USE ON CODE	A	B	C	D	(J) – (K)	E	F	G	H
#3 ~ #9	0	1,441±5	1,694±50	2,088±25	0±10	16,944±50	17,039±50	5,817±25	7,512±15
#10 ~ #46	0	1,441±5	1,694±50	2,088±25	0±10	16,944±50	17,039±50	5,817±25	7,512±15
#47 ~	0	1,441±5	1,694±50	2,088±25	0± 8	16,944±50	17,039±50	5,817±25	7,512±15



Alignment Check
Figure 2–3



Nose Cone Installation
Figure 2–5



TENSION

MS 20004 Bolts

Note: 1. Torque Value 70~90in-lb Except as Noted

Installation of Fuselage Aft Body
Figure 2–6

The gage and material of the fuselage skin are roughly as follows:

Fore from Sta -10260	2024C-T42	0.032"
Sta -10260 to Sta +8080	2024C-T3	0.032"
(however, fuselage-wing joint sections use:	2024C-T3	0.05" to 0.063")
Aft from Sta +8080	2024C-T42	0.032"

There are 66 longerons, which decrease in number gradually in the fore and aft portions of the fuselage as the extreme ends are approached. Most longerons are made of "Z" shape material; some longerons, angle shape plate. The material of the longerons is mostly 7075C-T6.

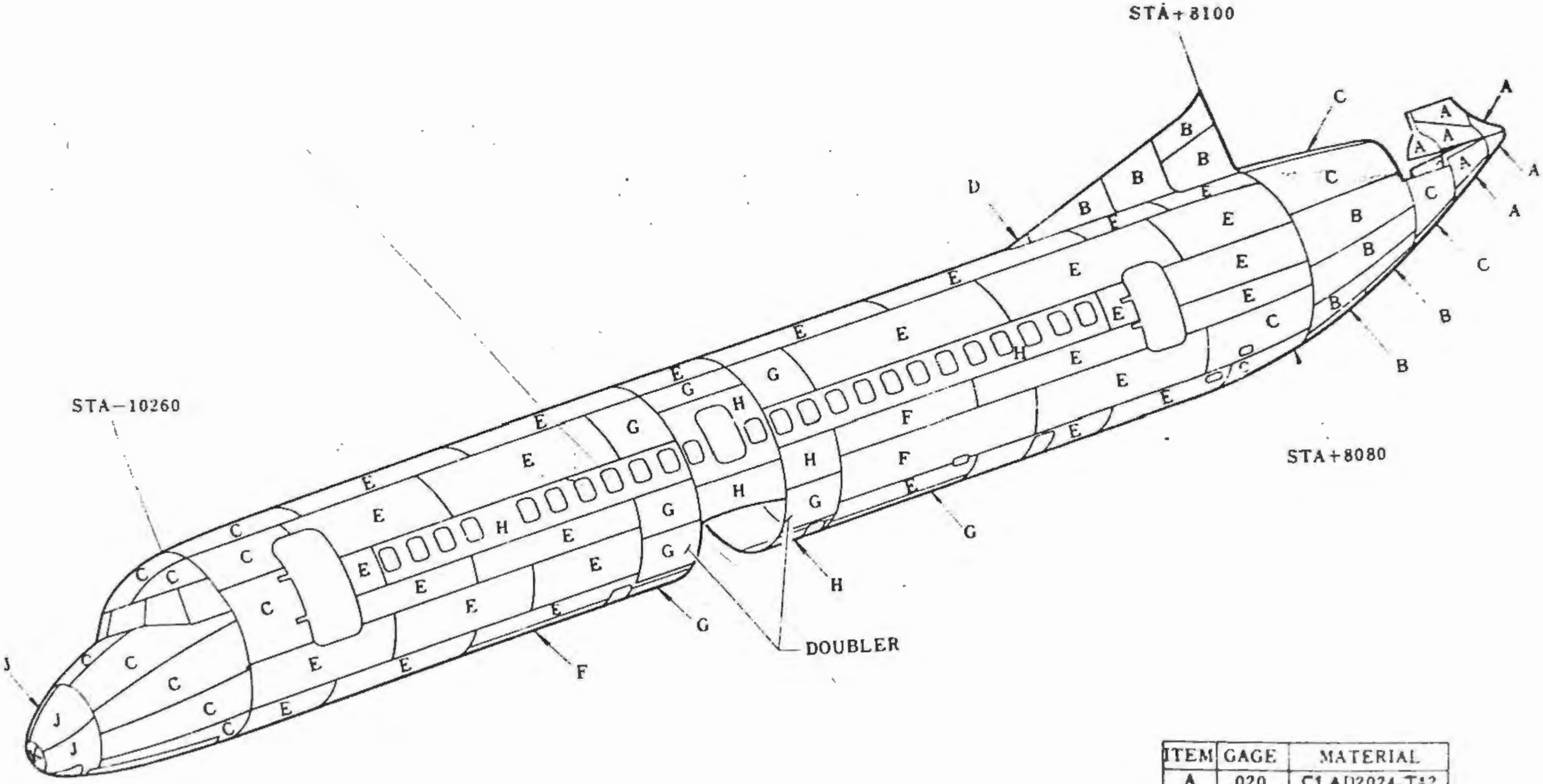
The frames are located at the station numbers shown in Fig. 2-1. In the center and aft fuselages, the most of the frames have a "Z"-shape cross section and is made of 7075C-T6, 0.050" or 0.056" thick. In the forward fuselage, the most of the frames have "⊏" shape cross-section and is made of 7075C-T6, 0.050", 0.056" or 0.063" thick. The frames in the joint sections of the forward, mid and aft fuselages are made of K2008 or K2009 extruded shape material.

At Sta -10560 is attached a frame to support the nose gear wheel keel. At Sta -1080 and Sta -2550 are attached frames to fix the main wing. At Sta +8554, Sta +10375 and Sta +11430 are attached frames to fix the tail wing. Those frames are made especially strong to bear their respective loads.

2.2.3 Sealing of Fuselage

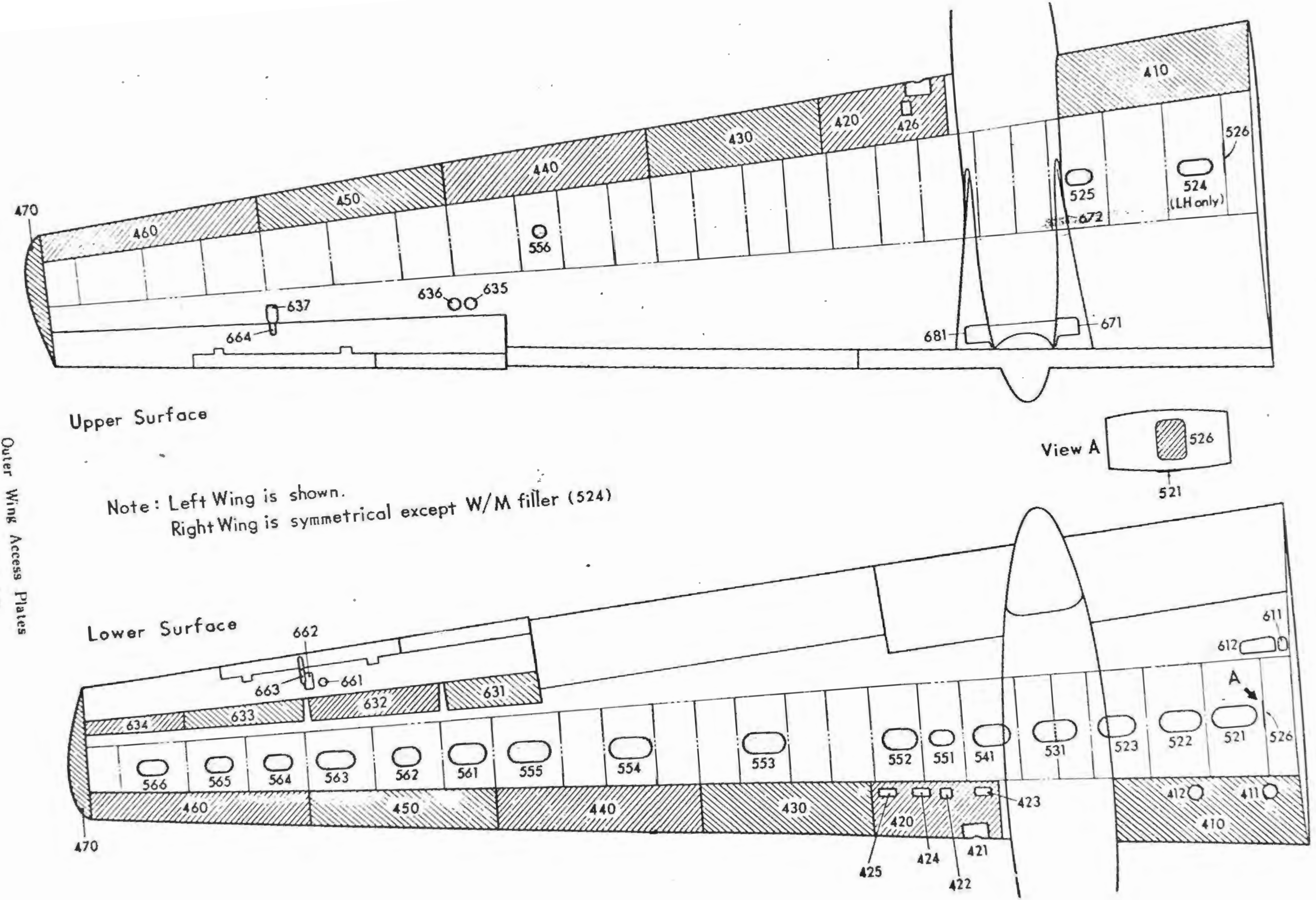
Sealing is broadly classified into air-tight sealing and water-tight sealing. Air-tight sealing is applied to the pressurized surface, where rivet and bolt heads are covered completely with sealing material.

The lap jointed portions of the skin are riveted with sealing material in between. Water-tight sealing is applied from outside the aircraft to cover the ends of skin sheets at the joint sections.



ITEM	GAGE	MATERIAL
A	.020	CLAD2024-T42
B	.025	CLAD2024-T42
C	.032	CLAD2024-T42
D	.040	CLAD2024-T42
E	.032	CLAD2024-T3
F	.040	CLAD2024-T3
G	.050	CLAD2024-T3
H	.063	CLAD2024-T3
J	.025	6061-T6
K	.040	6061-T6

Fuselage Plates / Skin-General
Figure 2-8



Note: Left Wing is shown.
Right Wing is symmetrical except W/M filler (524)

Outer Wing Access Plates
Figure 2-10

Number	Side	Type	Purpose or Access to
611	L	H	Fuel Cross-feed Line Drain
"	R	H	Fuel Power Drain Valve
612	L, R	H	Pressure Refueling Panel
631	L, R	S*	Aileron Leading Edge *With Pin Hinge
632	L, R	S*	" * "
633	L, R	S*	" * "
634	L, R	S*	" * "
635	L, R	S	Aileron Stopper Adjustment
636	L, R	S	Aileron Stopper Adjustment
637	L, R	S	Aileron Push Pull Rod Cover
661	L, R	S	Spring Installation
662	L, R	S	Spring Unit
663	L, R	S	Aileron Spring Tab Push Pull Rod Cover
664	L, R	S	Horn-Spring Tab Cover
671	L, R	S	Exhaust Exit Construction
672	L, R	H	Life Line Fitting – (aft)
681		S	Exhaust Exit Construction

Note 1: Refer to 28-11-0 Integral Fuel Tank for Access Plate Mounting

Number	Side	Type	Purpose or Access to
611	L	H	Fuel Croos-feed Line Drain
"	R	H	Fuel Power Drain Valve
612	L, R	H	Pressure Refueling Panel
631	L, R	S*	Aileron Leading Edge *With Pin Hinge
632	L, R	S*	" * "
633	L, R	S*	" * "
634	L, R	S*	" * "
635	L, R	S	Aileron Stopper Adjustment
636	L, R	S	Aileron Stopper Adjustment
637	L, R	S	Aileron Push Pull Rod Cover
661	L, R	S	Spring Installation
662	L, R	S	Spring Unit
663	L, R	S	Aileron Spring Tab Push Pull Rod Cover
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672	L, R	H	Life Line Fitting – (aft)
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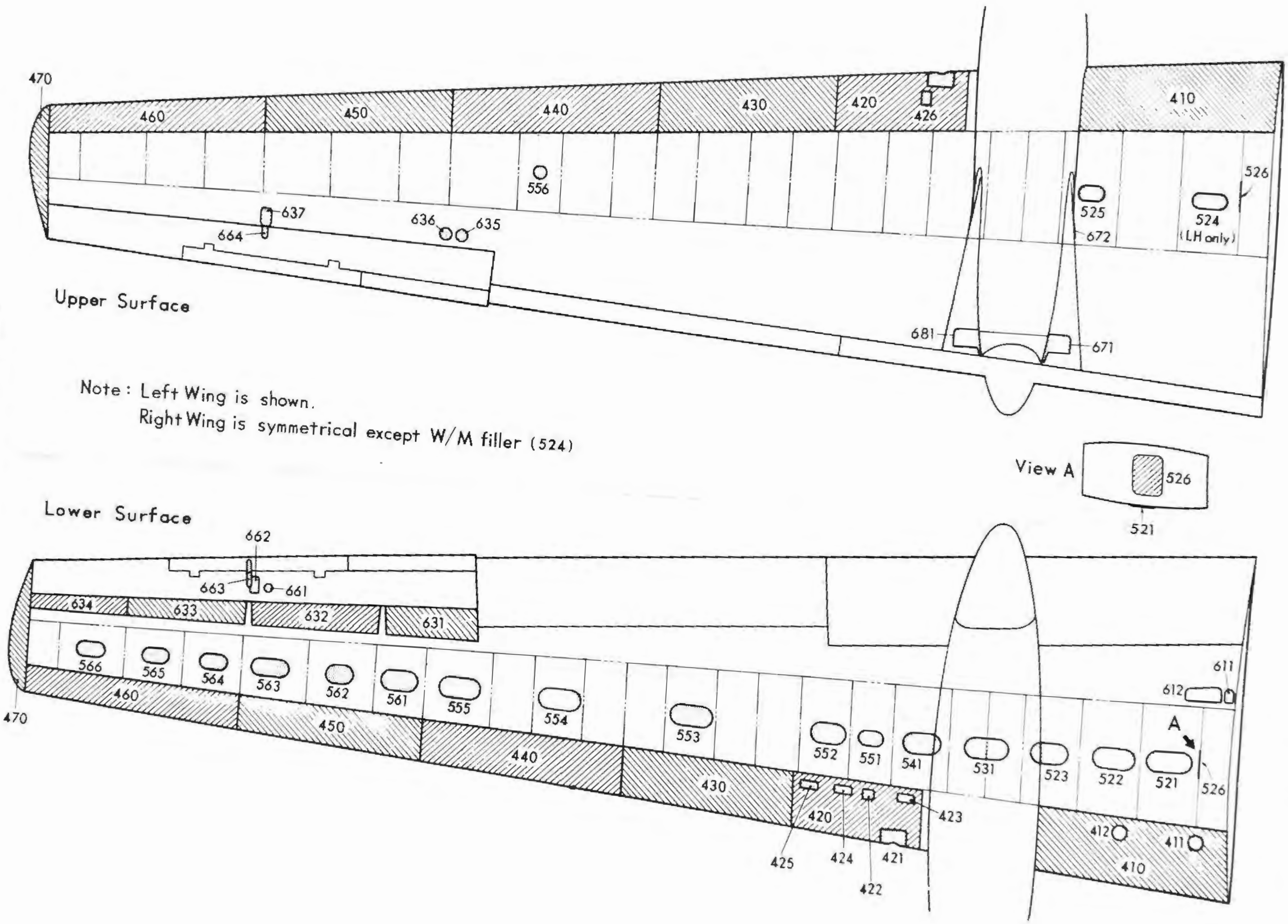
Note 1: Refer to 28-11-0 Integral Fuel Tank for Access Plate Mounting

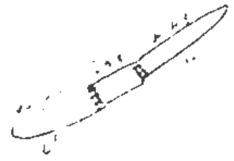


Note : Left Wing is shown.
Right Wing is symmetrical except W/M filler (524)

Outer Wing Access Plates
Figure 2-10

O/wing to fuse. c.

Upper 13 tension
lower - 11 "
Front - 7 shear
Rear 8 shear
Beam



2.3 Main Wing

2.3.1 General

The main wing has all-metal, cantilever, stressed-skin structure. It consists of center wing and outer wings. The center wing is fixed to the fuselage. The outer wings are fixed to the center wing at WS 0 with 13 tension bolts on the upper surface and 11 on the lower surface and with seven shear bolts on the front beam and eight on the rear beam arranged on the top and bottom ends. In the outer wings, the leading edges, trailing edges, tips, ailerons, flaps and nacelles are installed on the box-type structures consisting of front and rear spars, ribs, upper and lower skins and stringers.

The inside of the section between WS 4000 and WS 9600 forms an integral tank with its inside sealed.

Bag tanks can be installed in the section between WS 0 and WS 2482. The inner surface of the spar-to-spar structure in this portion is provided with lining plates.

2.3.2 Center Wing

The center wing is of two-spar box-type, fixed permanently to the center portions of the frames at Sta 2550 and Sta-1080 on the fuselage. It is composed of a front spar and a rear spar, upper and lower skins which have "⎍" shape stringers made of extrusion material and five reinforcing ribs. The reinforcing rib at BP 1100 has fittings for the wing-fuselage joint and the center wing-outer wing joint.

2.3.3 Outer Wing Spar-to-Spar Structure

The spar-to-spar structure constitutes the major structural part of the outer wing. The box beam of each wing is composed of a front spar and a rear spar, 24 ribs connecting these spars, and upper and lower skins reinforced with stringers.

The ribs have two varieties: the truss type and the web type. The truss type ribs are so designed that the truss members can be removed to facilitate work inside the wing.

2.3.4 Outer Wing Leading Edge Structure

The leading edge consists of six sections, each of which is fixed by screws to the ribs riveted to the front spar flange of the main wing.

The portion between the fuselage and the nacelle is formed with skin and false ribs, and has no anti-icing system. The portion of leading edge outside the nacelle has double skin, and is equipped with rubber boots and their piping.

2.3.5 Outer Wing Trailing Edge Structure

The trailing edge consists of ribs, stringers and skin, and is riveted to the rear spar. It supports the inboard and outboard flaps between WS 0 and WS 9038, and the aileron between WS 9038 and WS 14400.

The ribs in the trailing edge of the flap comprise two varieties: cantilever ribs and false ribs. Their stiffeners are detachable.

The rear end of the lower surface skin is rubber-sealed to fill the clearance between the lower surface of the trailing edge and the flap at the time of FLAP UP configuration.

In the trailing edge of the aileron assembly, a bulkhead for aileron sealing cloth is installed spanwise. The lower side of the trailing edge forms an access door, which can be opened when the aileron is serviced.

2.3.6 Wing Tip

The wing tip consists of skin and seven fairing elements, and has a wing tip light. It is fixed to the outer wing with screws.

2.3.7 Outer Wing Skin

The material and thickness of the outer wing skin are shown in Figs. 2-17 and 2-18.

2.3.8 Flaps

The flap is of the Fowler type, and has two drag links with screw jacks to actuate the flap. Three roller carriages installed on the flap travel along the circular rails on the main wing trailing edge.

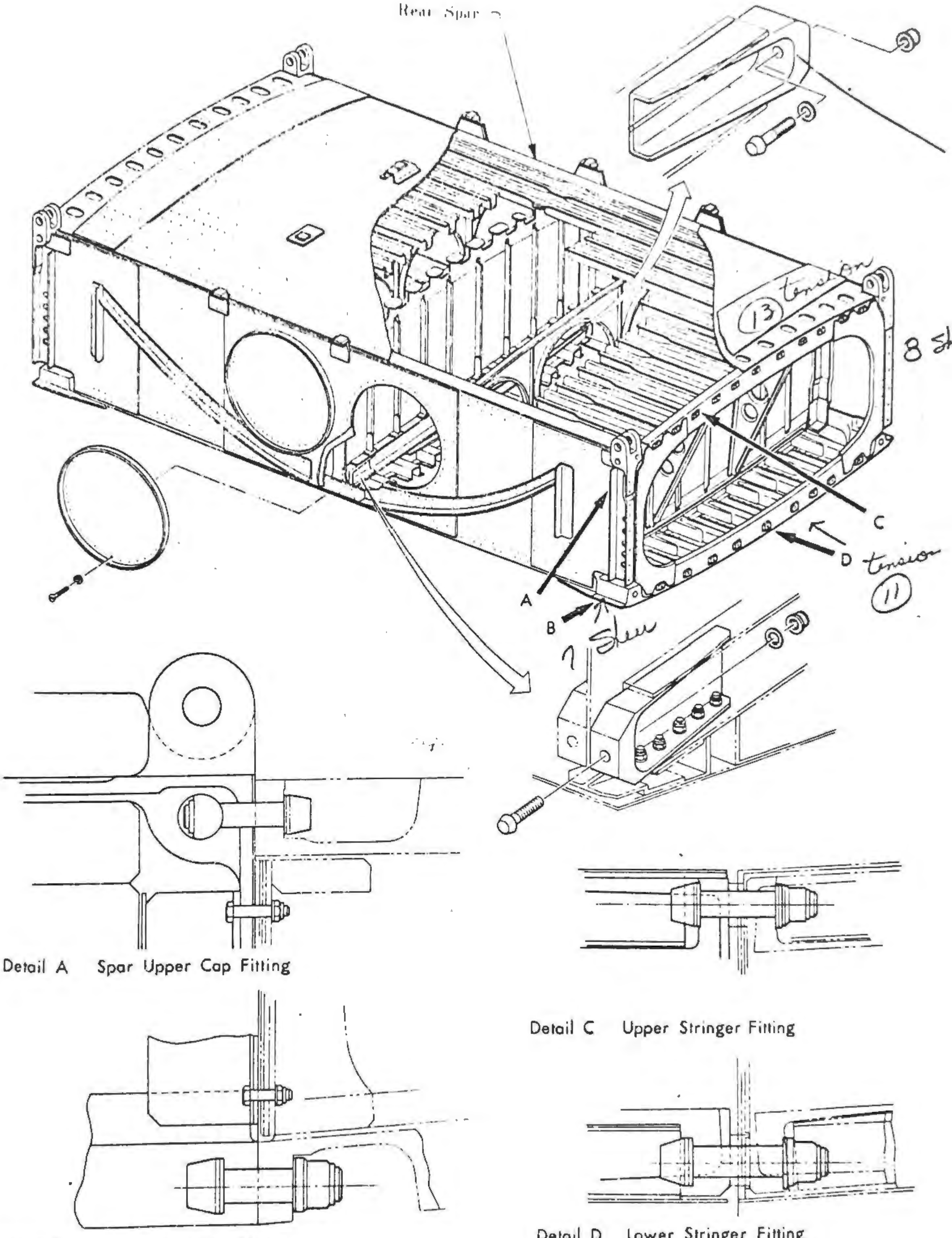
Both inboard and outboard flaps are composed of main spars and front and rear spars; the spars and ribs are formed by bending sheet. The skin is reinforced with stringers. On the lower side of the inboard flap, a fairing cone is installed to fair the rear of the nacelle at the time of FLAP UP configuration.

2.3.9 Ailerons

The aileron has all-metal, single-span, stressed-skin structure. Nylon curtain seal is provided on its leading edge. It is connected to the main wing trailing edge with five hinges.

A spring tab is located at the center of the trailing edge of each aileron; a trim tab is on the inboard side of the trailing edge of the L.H. aileron.

On the leading edge except the hinge portion, balance weights with bar shape are arranged spanwise to keep static moment at 250 ± 50 mmKg (nose-heavy).



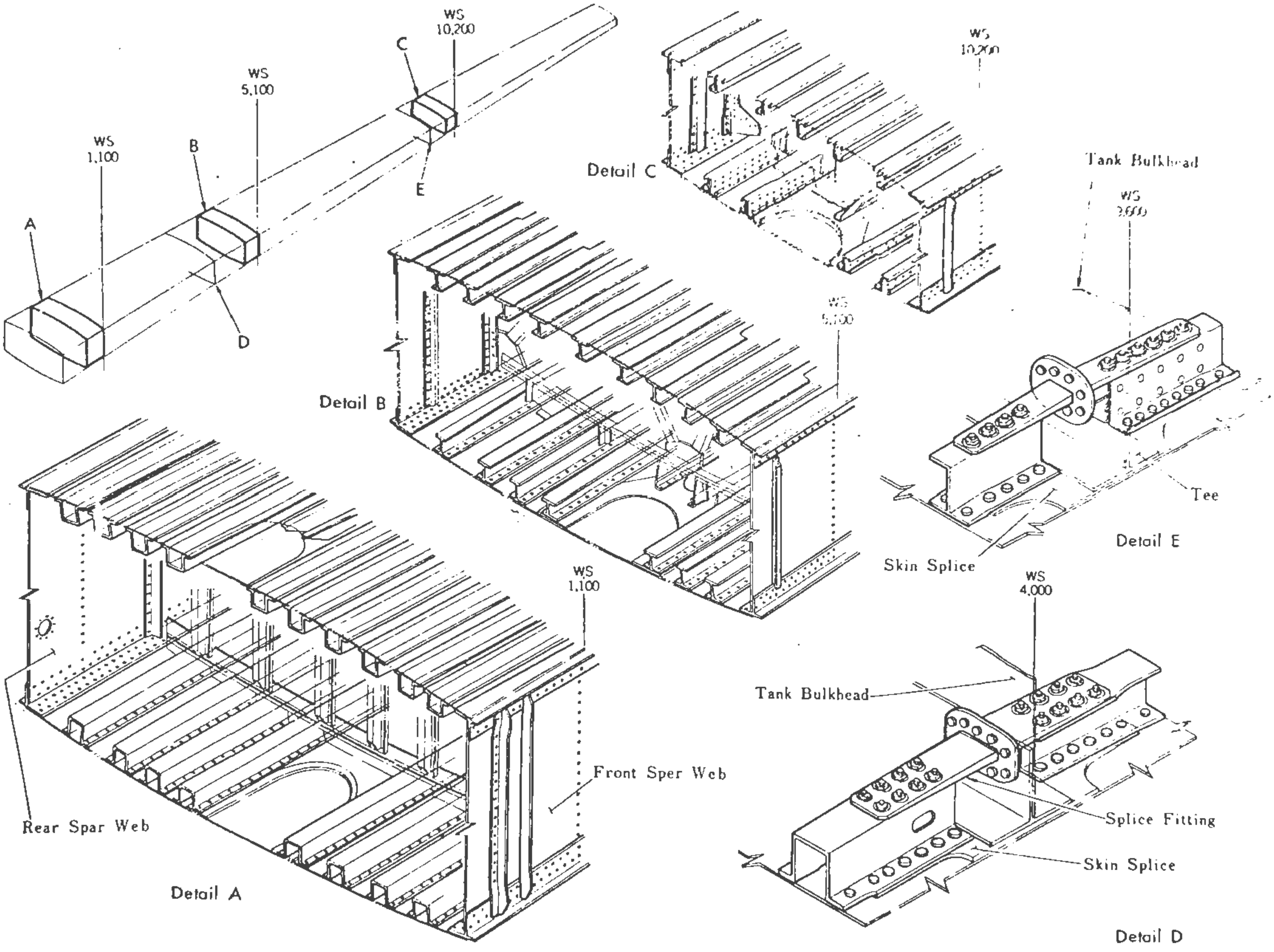
Detail A Spar Upper Cap Fitting

Detail C Upper Stringer Fitting

Detail B Spar Lower Cap Fitting

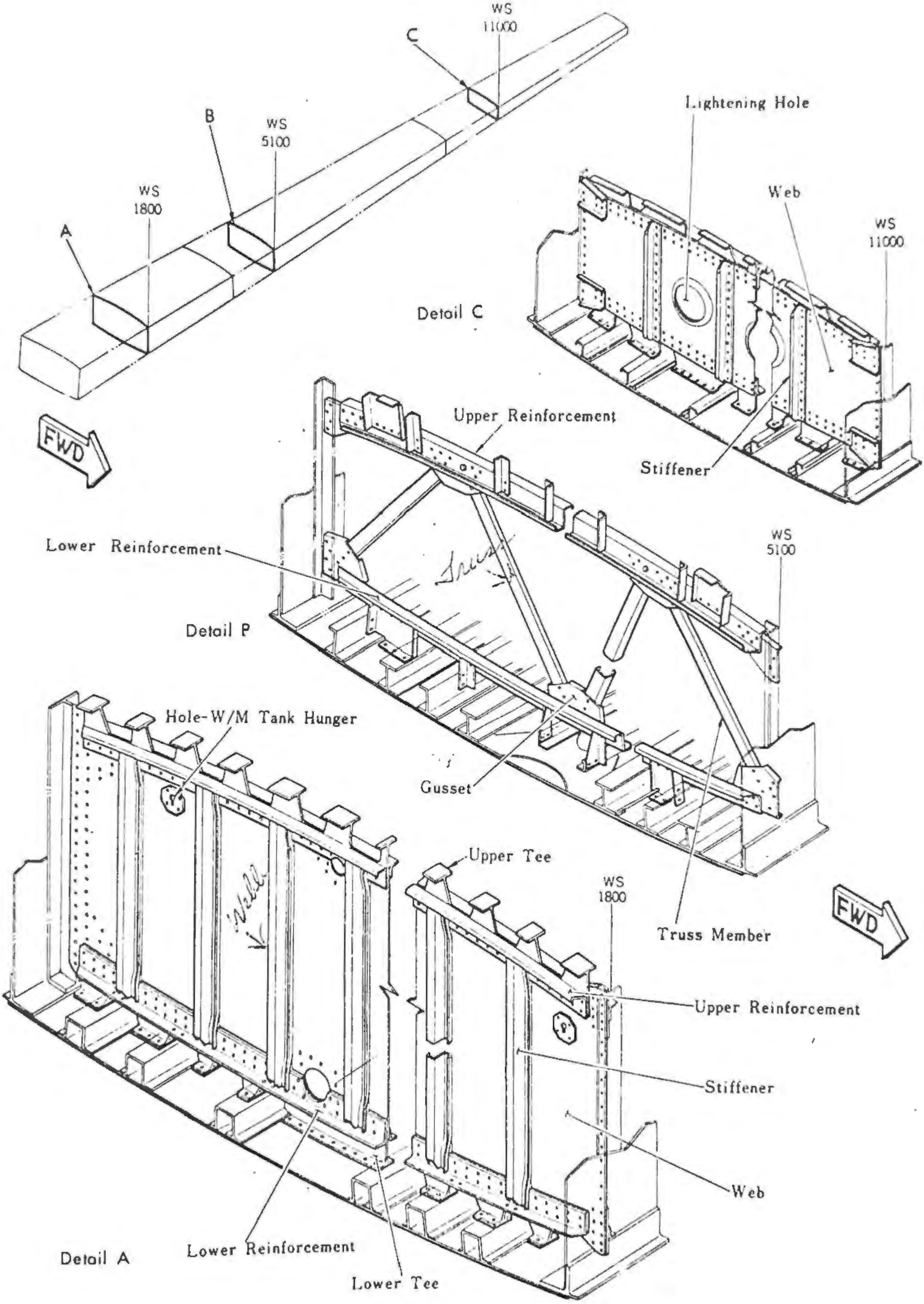
Detail D Lower Stringer Fitting

Center Wing Structure
Figure 2-11

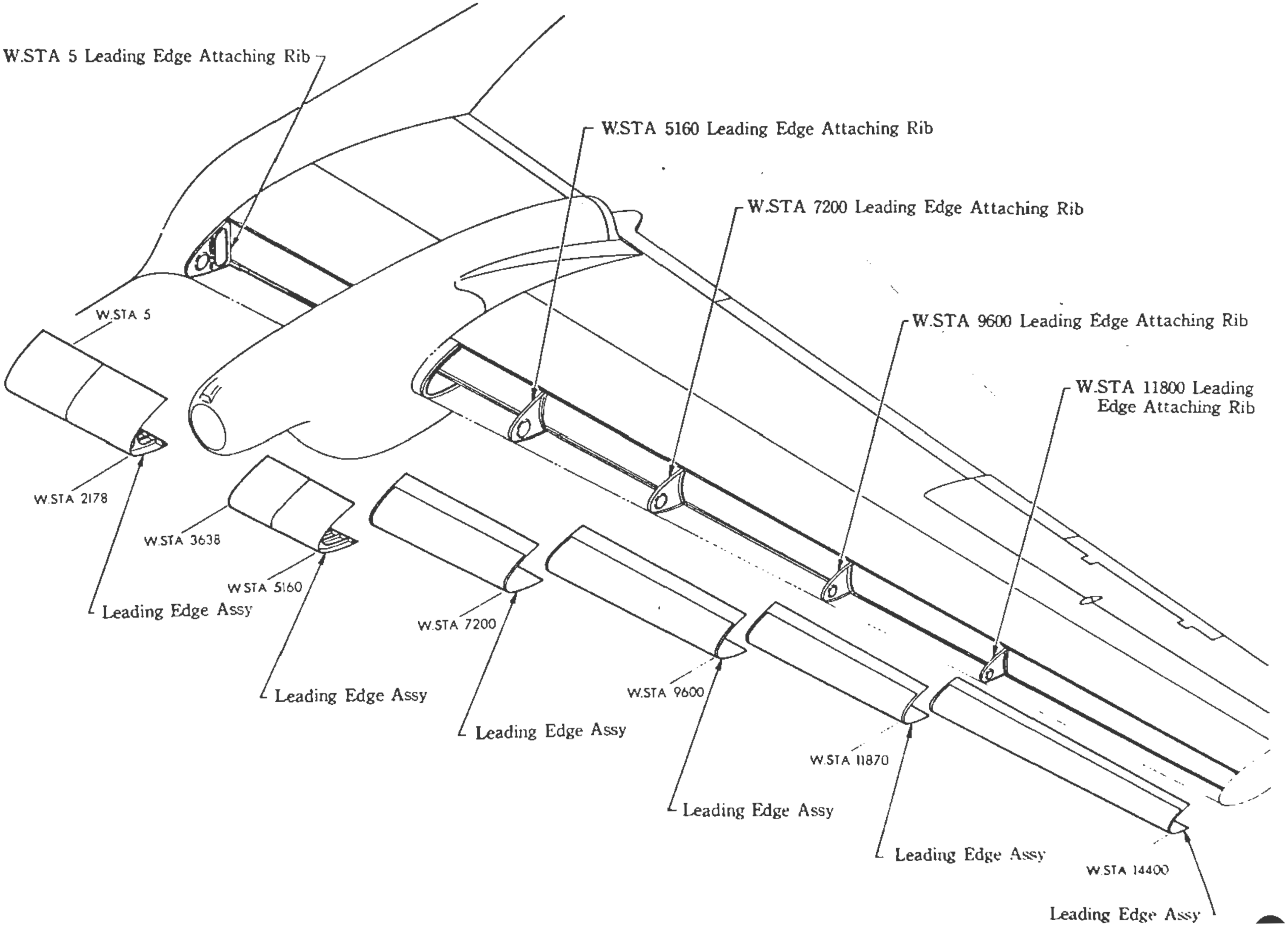


Box Beam Structure (Spars and Stringars)

Figure 2-12



Box Beam Structuce(Ribs)
Figure 2-13


W.STA 5 Leading Edge Attaching Rib
W.STA 5160 Leading Edge Attaching Rib
W.STA 7200 Leading Edge Attaching Rib
W.STA 9600 Leading Edge Attaching Rib
W.STA 11800 Leading Edge Attaching Rib
W.STA 5
W.STA 2178
W.STA 3638
W.STA 5160
W.STA 7200
W.STA 9600
W.STA 11870
W.STA 14400
Leading Edge Assy
Leading Edge Assy
Leading Edge Assy
Leading Edge Assy
Leading Edge Assy
Leading Edge Assy

Leading Edge Component
Figure 2-14

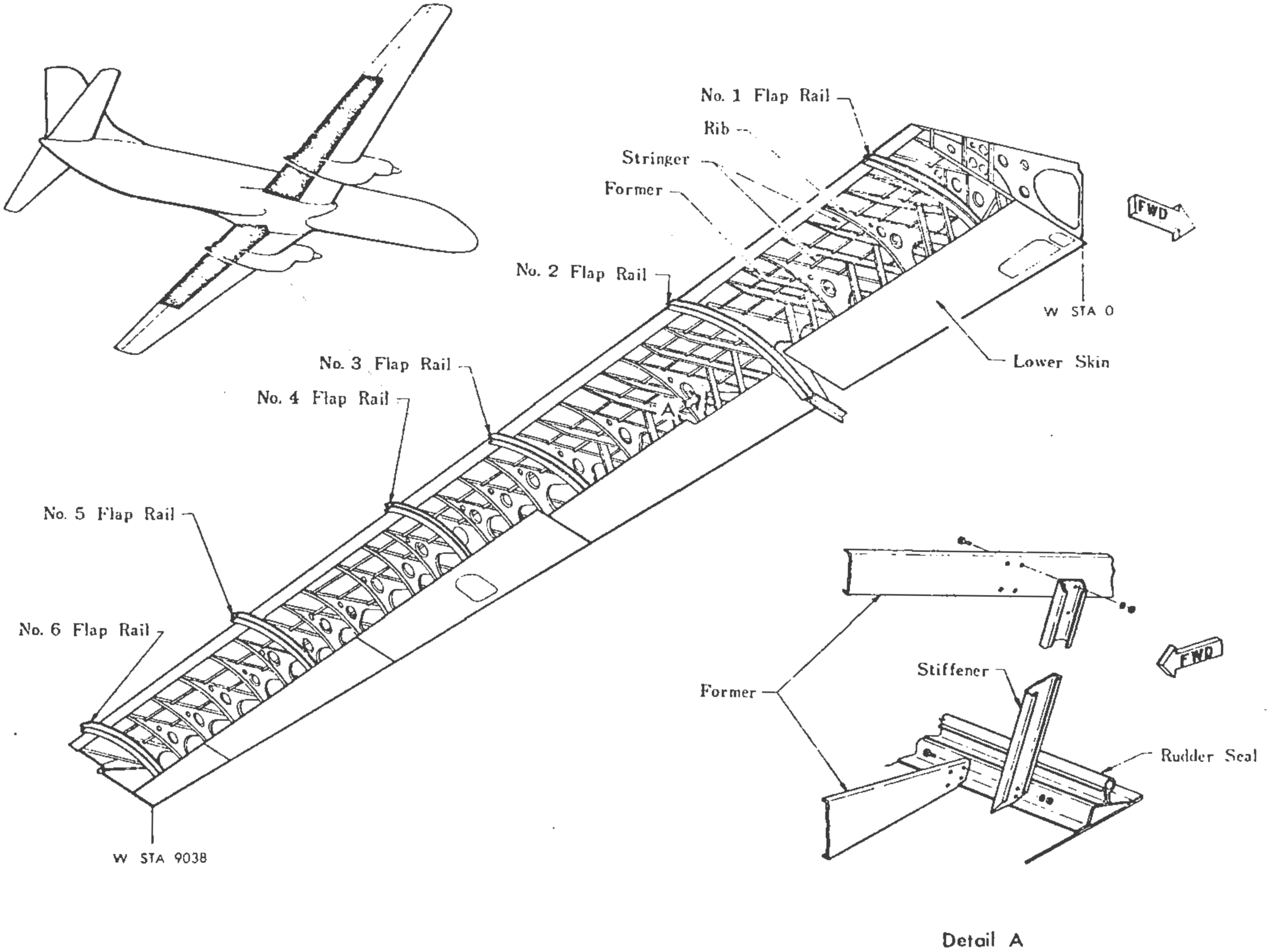
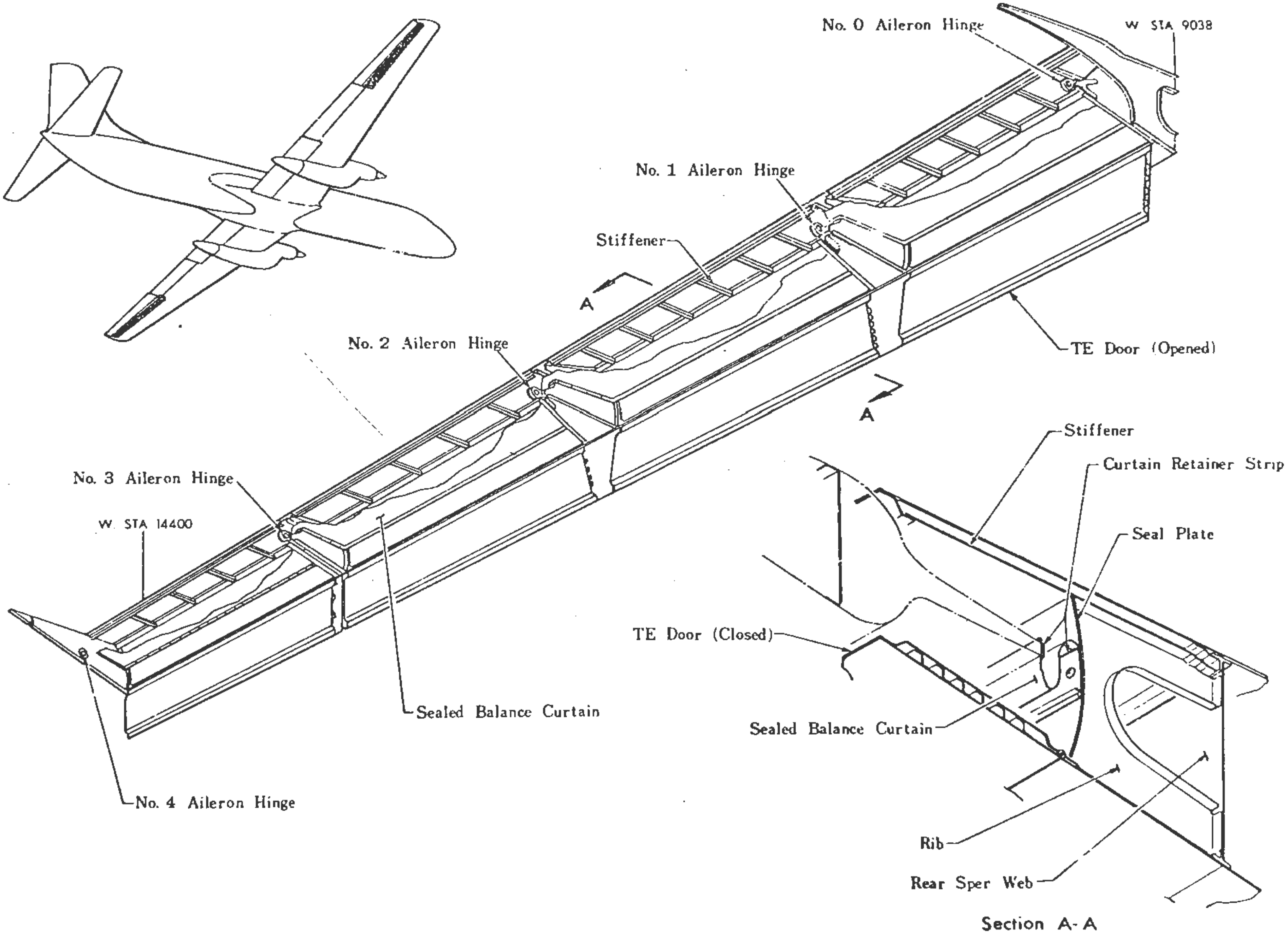
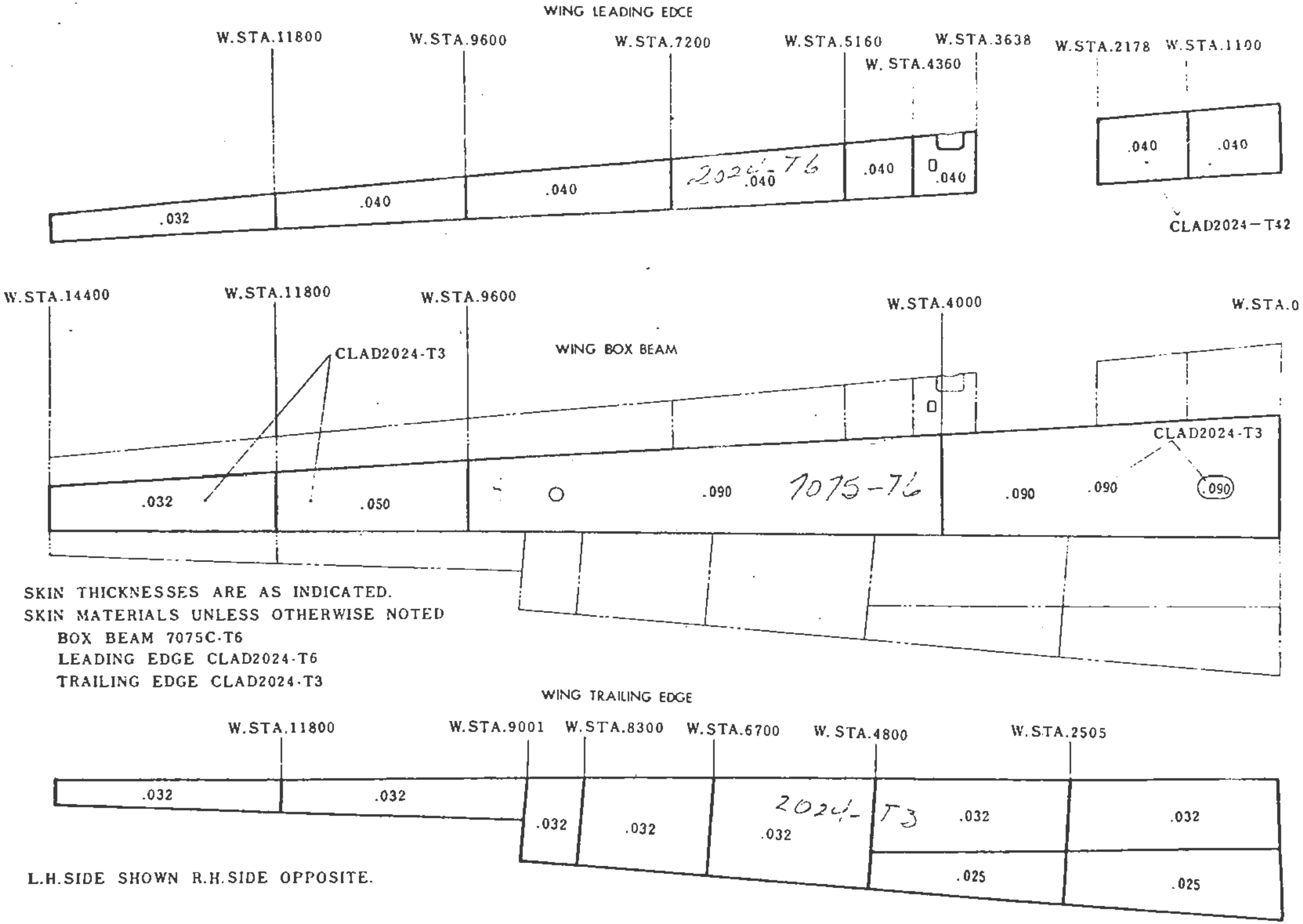


Figure 2-15
Trailing Edges

The tabs are all-metallic. The spring tab is joined to the aileron with hinges at three points, and trim tab, with piano hinges. Static moment of the spring tab is 10 ± 3 mmKg (nose-heavy).



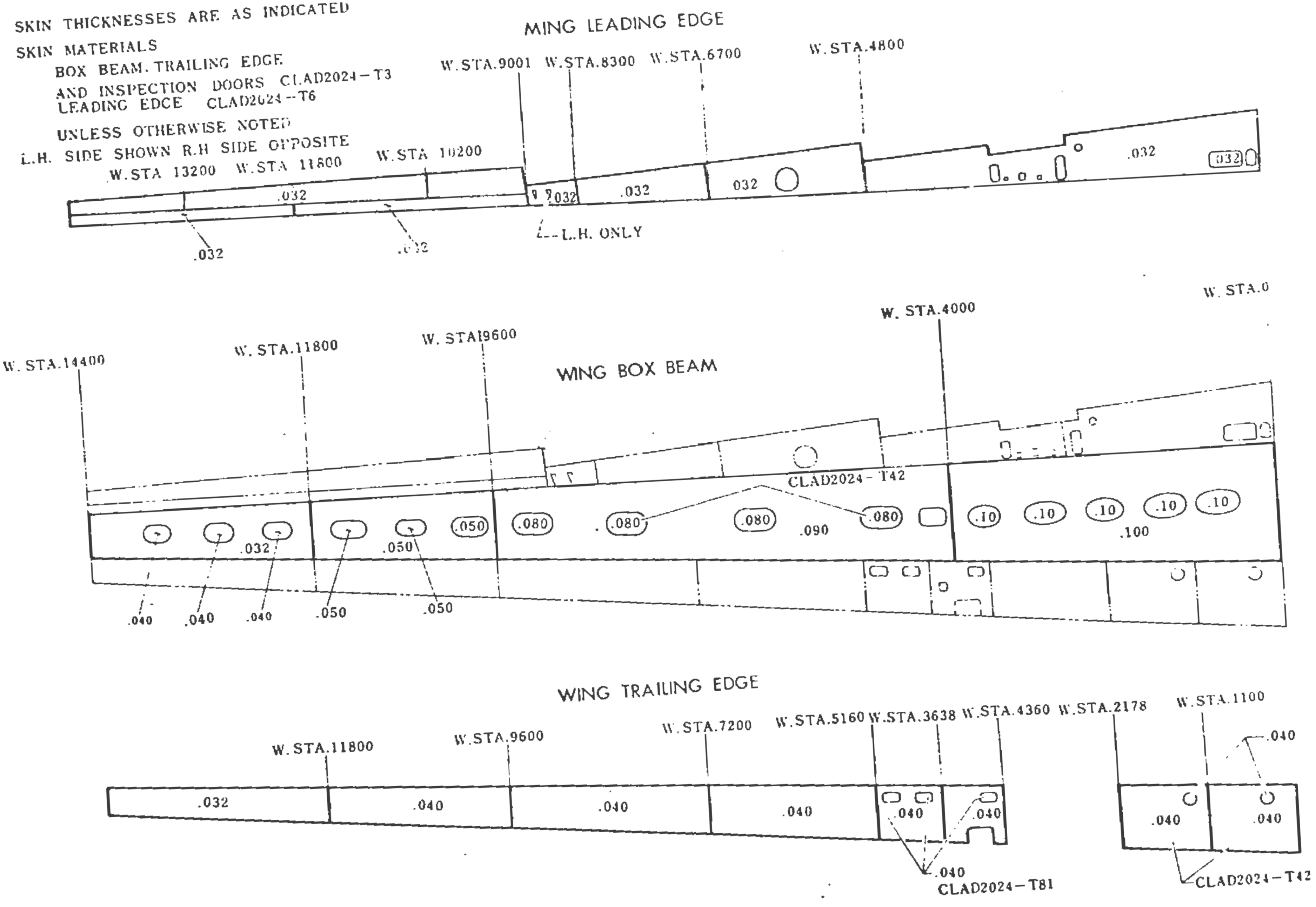
Trailing Edges
Figure 2-16



SKIN THICKNESSES ARE AS INDICATED.
SKIN MATERIALS UNLESS OTHERWISE NOTED
BOX BEAM 7075C-T6
LEADING EDGE CLAD2024-T6
TRAILING EDGE CLAD2024-T3

L.H.SIDE SHOWN R.H.SIDE OPPOSITE.

Skin Sections – Outer Wing Section, Top
Figure 2-17



Skin Sections-Outer Wing Section Bottom
Figure 2-18

2.4 Tail Wing

2.4.1 General

The tail wing consists of all-metal horizontal stabilizer, vertical stabilizer, elevators, rudder and fillets, each of which is detachable.

The stabilizers and the rudder have stressed-skin structure with spars, longerons and skin as reinforcing members. The top ends of the vertical stabilizer and the rudder are made of formed fabric reinforced plastic material; the others are made primarily of material 2024.

As for the fillets, part of the dorsal fin is fixed to the upper part of the aft fuselage, and the others are detachable, streamlining the aft fuselage, the tail cone and the tail wing joint section.

Fig. 12-19 shows the inspection holes and the servicing holes for maintenance of the tail wing.

2.4.2 Horizontal Stabilizer

The horizontal stabilizer has two-spar structure; the front and rear spars are located at 17.5% and 55% of wing chord, respectively. The right-hand and left-hand stabilizers are connected at the center of the fuselage to form a monocoque structure. The portion between the two spars is formed with ribs, longerons and skin. Joint fittings, four in all, are provided in front of H. Sta 770 and behind H. Sta 500 of the front spar. They mate with the joint fittings on the fuselage side, the forward portion being joined with two taper bolts and sleeves and the aft portion with two tension bolts.

Throughout the upper and lower sides of the front spar are provided hinges to which the leading edge assembly is attached with stainless steel wire. In the leading edge assembly, a rubber boot type anti-icing system is provided as in the main wing.

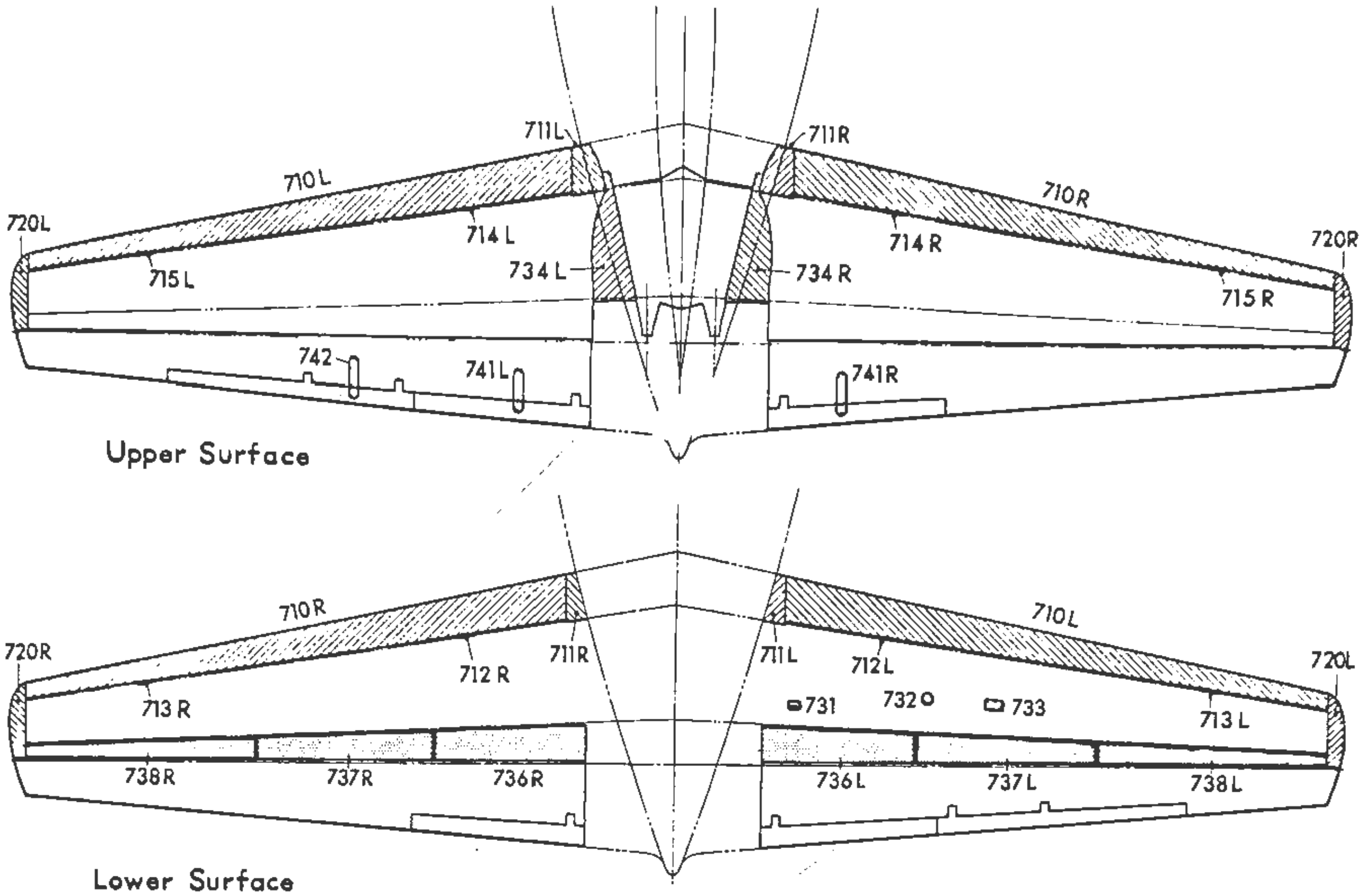
The trailing edge is faired with ribs. Hinges to install the elevator are located at H. Sta 300, 1400, 3 800 and 5 800 of the rear spar.

The lower side of the trailing edge forms an access door opening downward with hinges.
A vortex generator is installed in front of the door of the lower side.

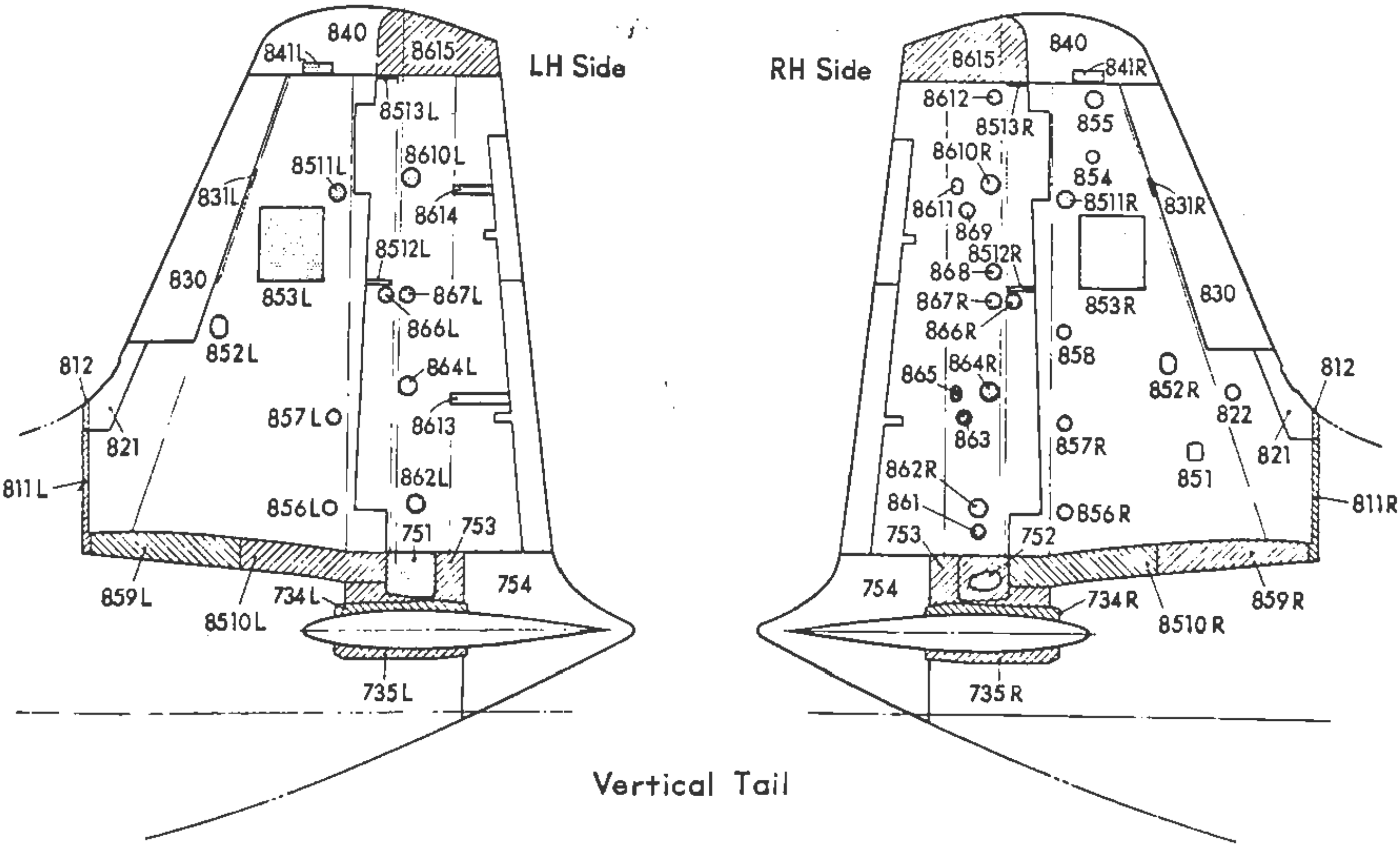
The wing tips made of 6061 aluminium fabricated by welding and forming, are attached to the ends of the wings. A flux valve for the C-9 gyrosyn compass is provided in a horizontal tail wing tip.

2.4.3 Elevators

The elevator, consisting of right-hand and left-hand surfaces and center torque tube, has all-metal structure except the tip.



Horizontal Tail



Vertical Tail

Tail Plane Access Plates

Figure 2-19

Number	Side	Type	Purpose or Access to
8510	L, R	S	Filet
8511	L, R	S	WHF Antenna Cable
8512	L, R	S	Rudder Hinge Cover
8513	L, R	S	"
861	R	S	Rudder Spring and Trim Tab Linkage
862	L, R	S	"
863	R	S	Rudder Lower Spring and Trim Tab Push Pull Rod
864	L, R	S	"
865	R	S	"
866	L, R	S	Rudder Hinge and Idler Arm
867	L, R	S	"
868	R	S	"
869	R	S	Rudder Lower Spring and Trim Tab Push Pull Rod
8610	L, R	S	"
8611	R	S	"
8612	R	S	Rudder Hinge
8613	L	S	Rudder Spring and Trim Tab Rod Cover
8614	L	S	"
8615		S	Rudder Tip

The hinge points are at the horn fittings at H. Sta 5850, 3800, 1400 and 300.

Balance weights are mounted on the leading edge to keep the moment at 100 ± 25mmKg (nose-heavy) in the static condition.

The clearance between the elevator leading edge and the stabilizer rear spar is sealed with curtain seal.

There are balance tabs and trim tab, the former being inside the surfaces of both sides, and the latter outside the surface of the left side.

The tab hinge points and the moments in the static condition are:

Balance tab:	H. Sta 2 400, 1 600, 800	8 ± 3 mmKg (nose-heavy)
Trim tab:	H. Sta 4 600, 3 995, 3 200	$5 \pm {}^{0}_{5}$ mmKg (nose-heavy)

2.4.4 Vertical Stabilizer

The vertical stabilizer has two-spar structure, with the front and rear spars located at 18% and 60% of the wing chord respectively. The leading edge assembly is connected to the front spar with stainless steel wire. A rubber boot anti-icing system is provided in the leading edge assembly.

The vertical stabilizer is attached to the fuselage with joint fittings on the front and rear spars by means of two taper bolts and sleeves at Shear the front and two tension bolts at the rear. Between the spars, "J"-section longerons extend in the longitudinal direction. The stabilizer is faired with 19 ribs. The trailing edge has a fairing sheet contributing to the performance and aerodynamic effect of the rudder. Rudder hinge fittings are installed at three points.

At the center, the stabilizer is hollowed to contain a VOR antenna, which can be inspected and serviced from both sides. The tip is covered with fabric reinforced plastic molding. A VHF antenna adjuster is installed inside the tip.

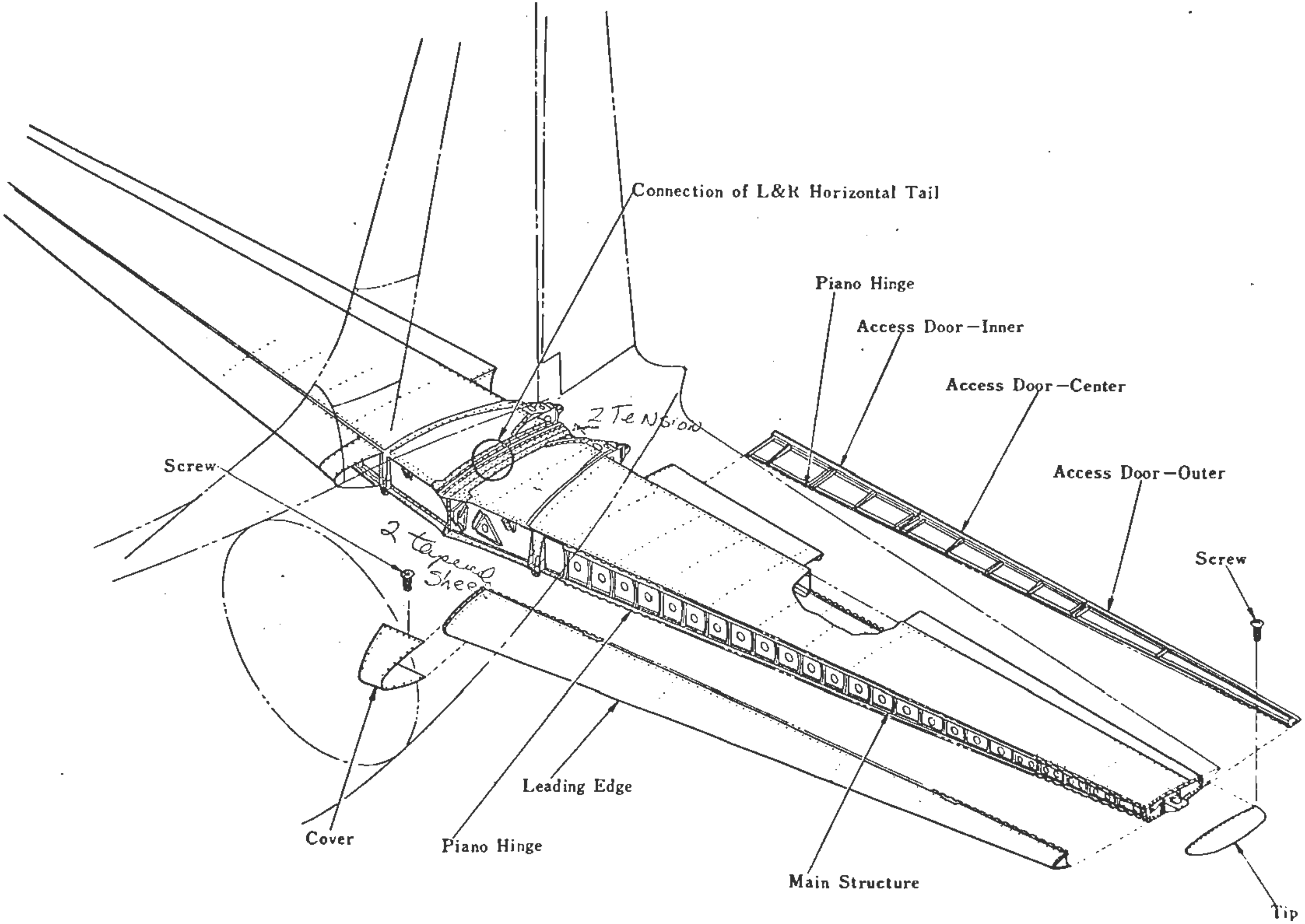
2.4.5 Rudder

The rudder has all-metal structure except its top which is made of fabric reinforced plastics. At the lower end, it has a torque tube and a quadrant with a tension regulator.

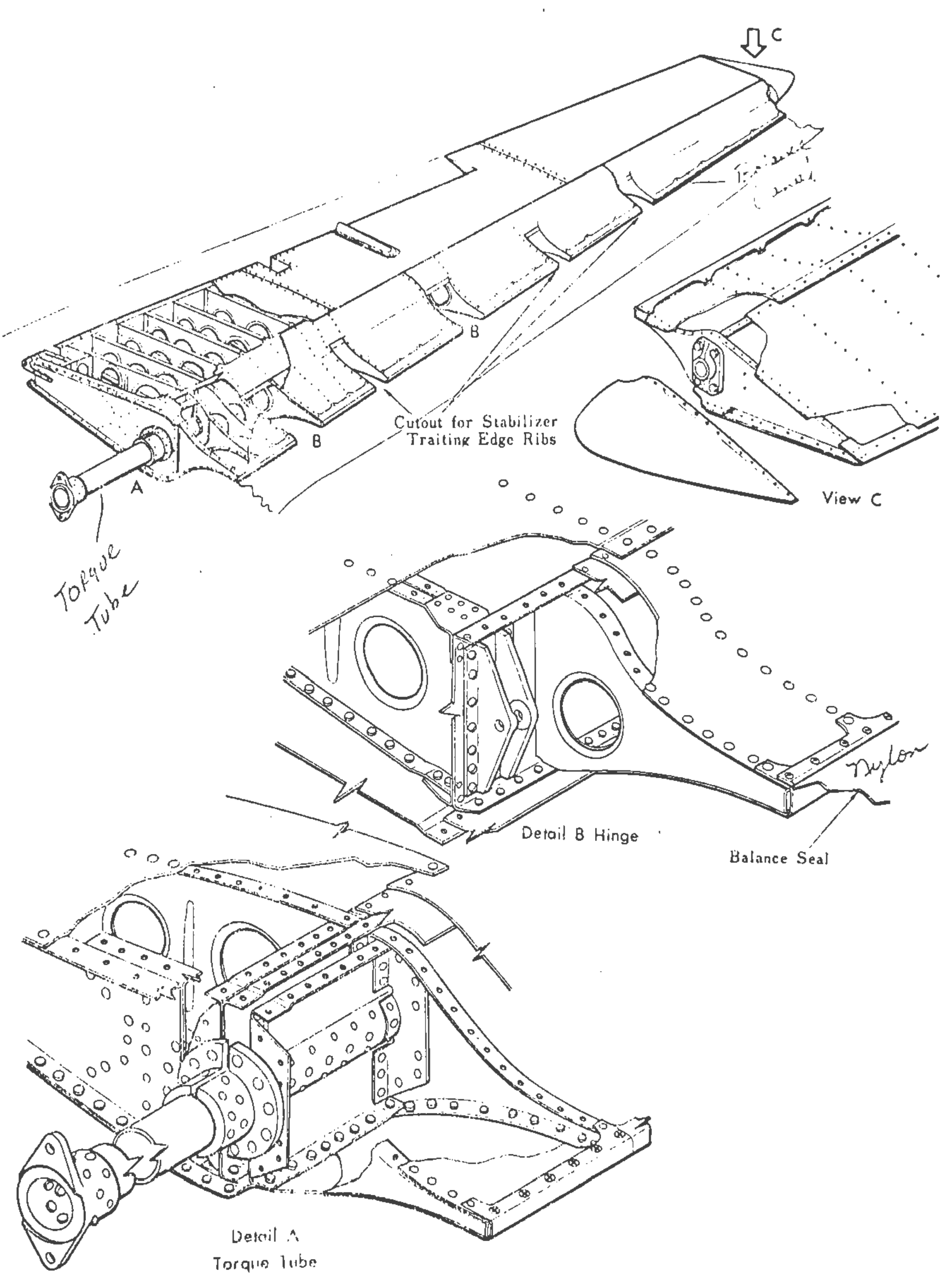
Rudder attachment hinges are provided at three points (V Sta 4000, 2250 and -170).

The hinge at V Sta -170 takes load in the direction of hinge line. Balance weights are distributed in the balance horn in the section between V. Sta 3750 and 3000 of the leading edge and in the lower part of the leading edge.

Two pairs of upper and lower tabs, serving both as springs and as trim tabs, are provided on the trailing edge at the following locations:



Horizontal Stabilizer Components
Figure 2-20

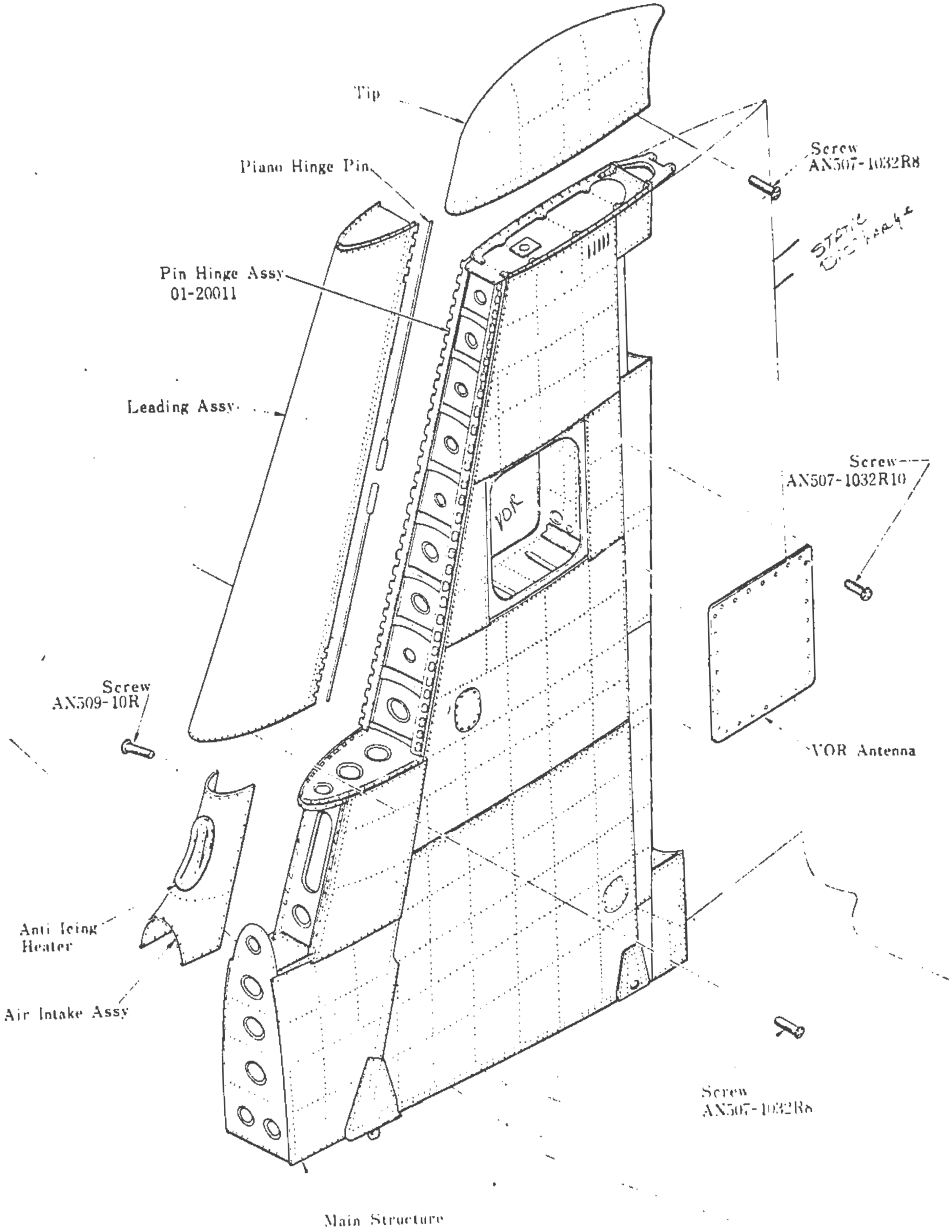


Elevator Structure
Figure 2-21

Upper spring and trim tab: V. Sta 3250 and 2500
Lower spring and trim tab: V. Sta 2000, 1000 and 0

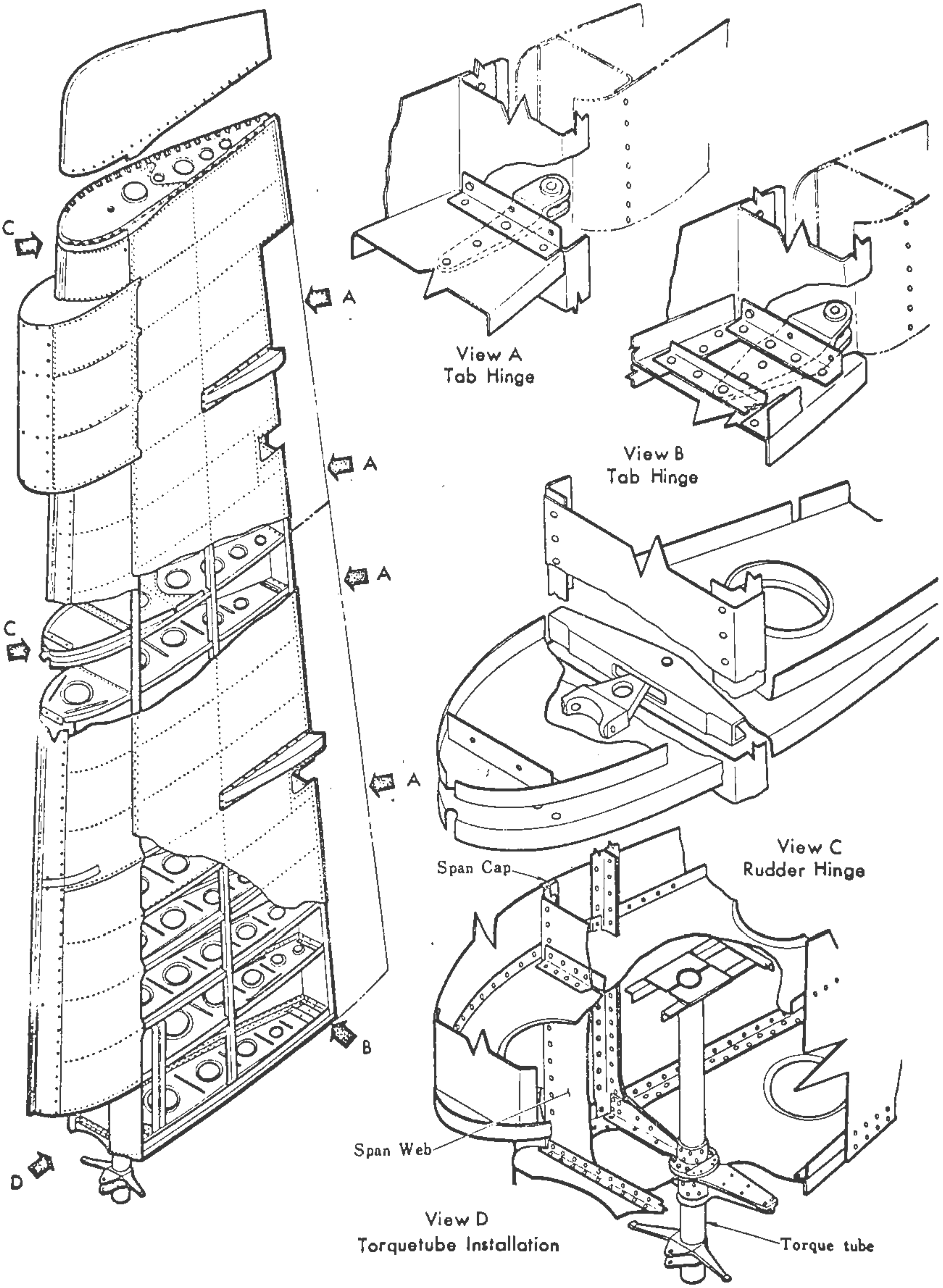
Two static dischargers are provided in the upper part of the rudder. Throughout the top of the leading edge of the rudder, rubber molding for sealing is provided to minimize the clearance between the leading edge of the rudder and the trailing edge of the stabilizer. Moments in the static condition are:

Rudder: 1,000 ± 100 mmKg (nose-heavy)
Lower tab: 12 ± 3 mmKg (nose-heavy)
Upper tab: 7 ± 3 mmKg (nose-heavy)



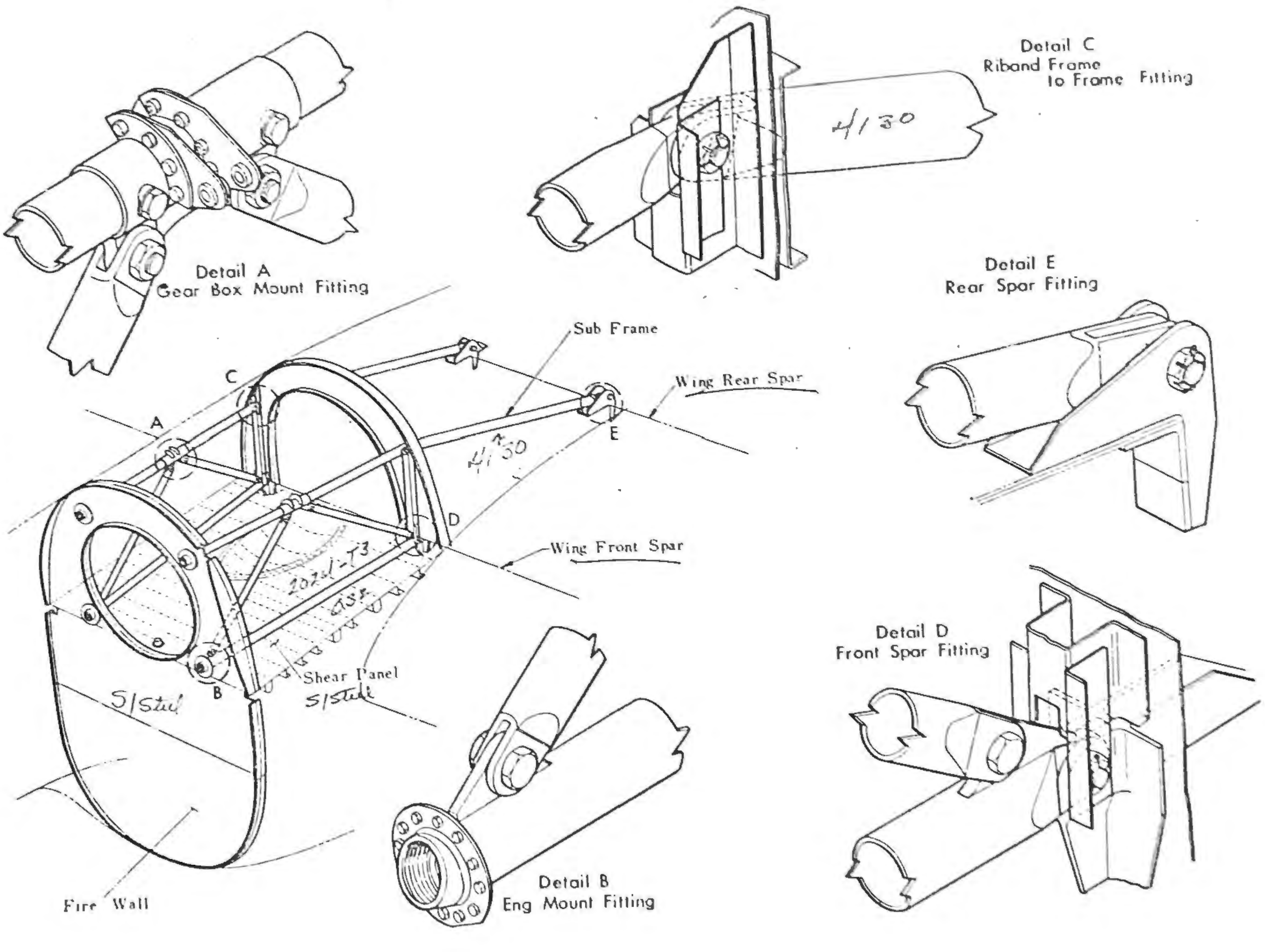
Vertical Stabilizer Components

Figure 2-22

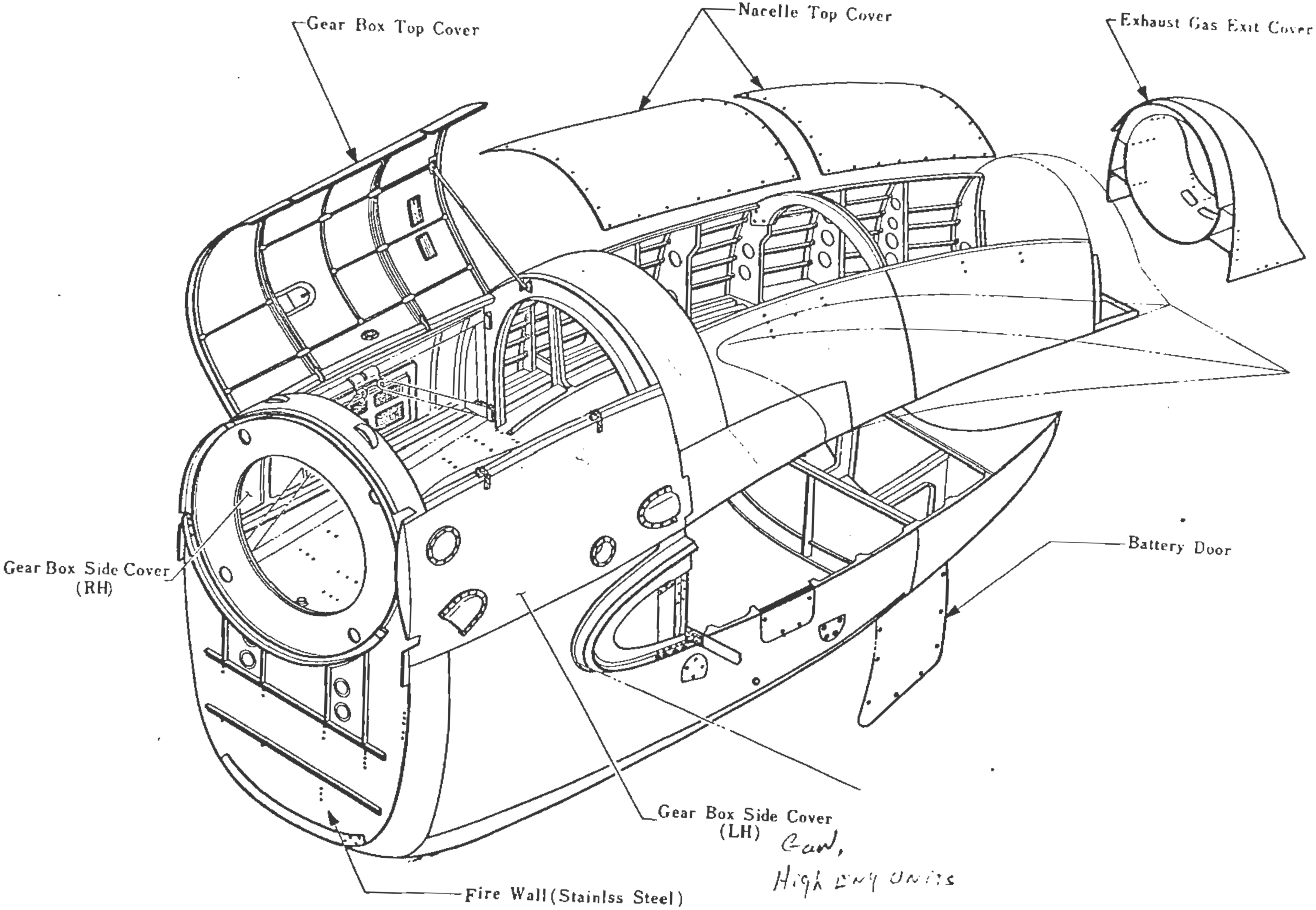


Rudder Structure

Figure 2-23



Nacelle Main Frame
Figure 2-24



Nacelle Covers
Figure 2-25

Carl,
High eng units
7 Air [illegible]

2.5 Nacelle

2.5.1 General

Each nacelle is all-metallic, and is permanently fixed to the outer wing. It consists of main structural elements such as a firewall, sub-frame and shear panel, and auxiliary structural elements such as ribs, stringers, skins and covers.

The sub-frame is bolted to the spar-to-spar structure of the outer wing, with its forward end connected to the engine mount through the firewall.

Engine exhaust pipe penetrates the upper part of the nacelle to its aft end. An accessory drive gear box is installed above the said part.

The lower part of the nacelle constitutes a space to house the main landing gear and the batteries.

On both sides in the rear of the nacelle firewall and on its back, there are detachable covers, five in all.
FRP-made fillets for fairing are fixed on both sides of the rear of the nacelle.

2.5.2 Material for Structure

The sub-frame is made of ten 4130 steel tubes, and is connected to the front and rear spars of the outer wing through fittings at W.S. 2482 and W.S. 3334. The engine mount is installed on the forward end of the sub-frame through the firewall.

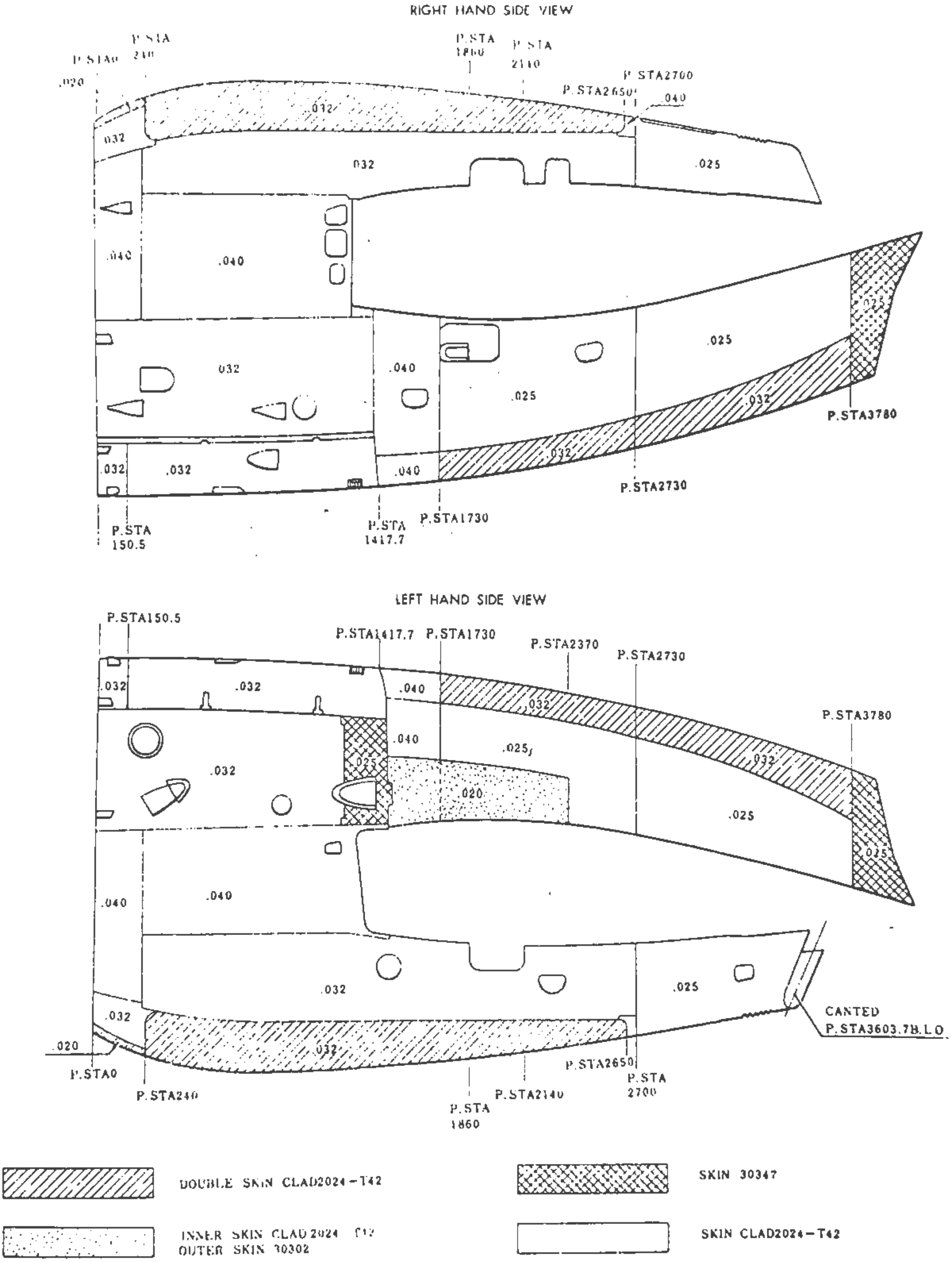
The sub-frame has fittings at its center to install the gear box.
End fittings are welded to the joint portion of the frame.

The firewall consists of webs made of 30302 stainless steel 0.025 inch and 0.50 inch in wall thickness and ribs made of 30347 material. The wall has hinge fittings for the cowling, and is penetrated by the power control units and fuel piping.

The shear panel, made of 2024-T3 material, is in the lower part of the sub-frame. It is riveted to the firewall, the ribs in the upper part of the front spar and the skin.

The sub-frame is fixed to the arch-shaped ribs in the upper part of the front spar. The lower ribs have landing gear door center hinges.

The filets, made of FRP, are fixed to the nacelle skin and the main wing upper skin with screws.
Fig. 2-26 shows the material and thickness of the skin.



Nacelle Skin and Doublers
Figure 2-26

2.6 Door

2.6.1 General

The pressurized portion of the fuselage has the doors listed in Fig. 2-28 All those doors open outward. When the doors are closed, airtightness is maintained by the rubber seals attached to the doors and the strikers on the fuselage side. The following table shows the dimensions of each door and the number of its latches:

Name of door	Number of latches or hooks	Dimensions (m)
Main Entrance	9(Latch Rod)	1.60 x 1.00
Service	6(Latch Rod)	1.22 x 0.64
Foreward Cargo	6(Latch Rod)	1.25 x 0.84
Aft Cargo	6(Latch Rod)	1.22 x 0.80
Emergency Exit	4(Latch Rod)	0.73 x 0.48
Electric Access	2(Hook)	
Belly Cargo	2(Hook)	
Flight Control Access	2(Latch Rod)	
Hydraulic Access	2(Latch Rod)	
Air Cond. Access-Fwd	2(Latch Rod)	
Air Cond. Access-Aft	4(Latch Rod)	

* As to Main Entrace Door, refer to Chapter 6, HYDRAULIC SYSTEM.

2.6.2 Cabin Door

(1) General

On the floor of the fuselage are main entrance door, forward cargo door, service door and aft cargo door. Of those doors, the latter three have the same structure and the same locking mechanism. (As to the main entrance door, refer to the chapter on hydraulic system.)

The said three doors employ double hinges which permit them to open outward by 180°. The doors can be opened and closed either from the outside or from the inside of the aircraft (the forward cargo door, from the outside only).

(2) Latching Mechanism

When the door is closed, six latch rods are inserted into the airframe side and lock the door. The latch rods take the pressure in the fuselage; the hinges take no load.

The handle open lock mechanism prevents the door from moving from the open position to the close position while the latch rods remain extended. That is, once the handle is set to the "open" position, it cannot be brought to the "close" position until the door takes the "close" position.

The hold open mechanism locks the door at the "open" position by interlocking the hooks on the door side with the claws on the airframe.

The handle mechanical lock mechanism prevents the door from opening by mistake during flight.

With the handle set to the "close" position, the end of the interior handle automatically catches the handle lock lever.

Consequently, the handle cannot be moved unless the handle lock lever is pushed downward.

(3) Differential Pressure Lock

The differential pressure lock has a pressure locking claw which fixes the handle lock lever in the lock position according to the movement of a diaphragm which senses the pressure difference between the inside and the outside of the cabin.

The diaphragm begins to move at 0.2 psi. min., and completes its movement at 0.4 ± 0.1 psi max.

2.6.3 Emergency Exit Door

The emergency exit door opens outward together with the window frame. Door operating handles are provided both inside and outside the aircraft; so the door can be opened either from the inside or the outside.

This door also has a differential pressure lock mechanism which prevents the door from opening during flight.

The door is piano-hinged at its bottom.

2.6.4 Underfloor Access Hole and Door, and Inspection Hole

Each door is supported with two piano hinges.

The doors of the belly cargo compartment and the electric compartment have handles on their external sides. They can be locked with two latch hooks.

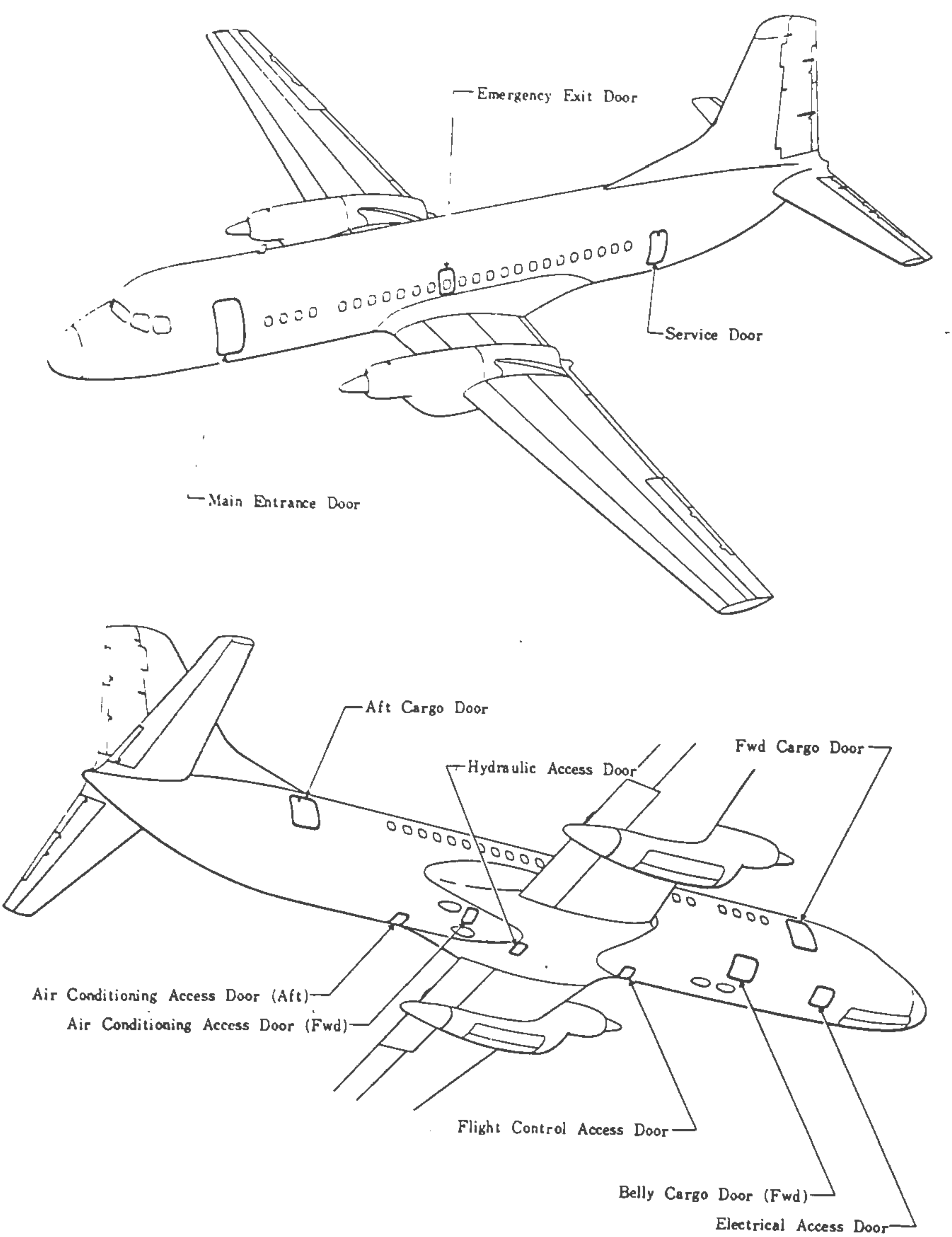
The door actuating mechanism unlocks the hook when the door handle is placed in the "open" position and automatically locks it with spring force when the handle is placed in the "close" position.

The doors of the flight control, hydraulic and air-conditioning compartments are locked by bayonets.

On the inspection hole in the aft fuselage which is not pressurized, an ordinary access panel is attached with fasteners.

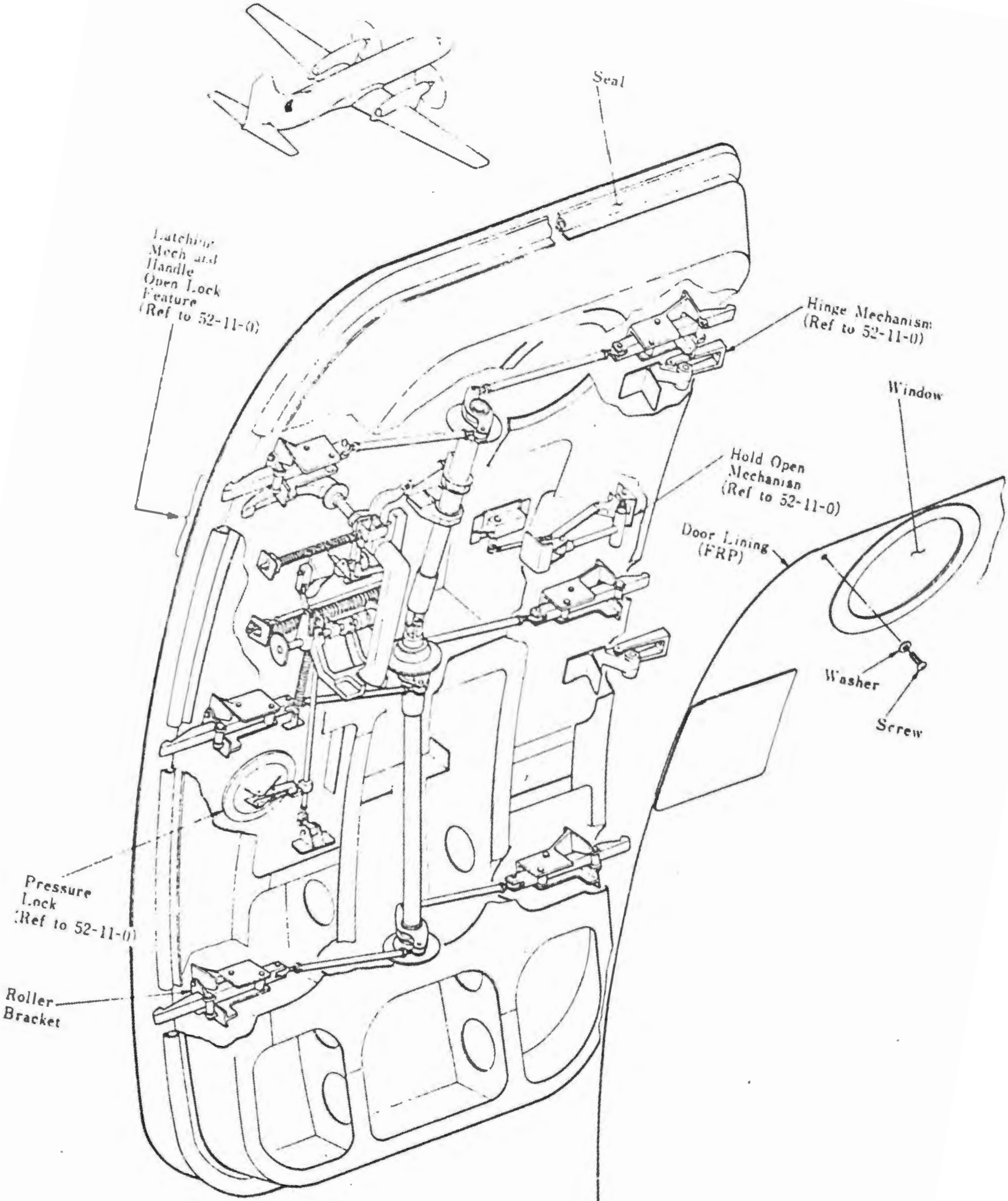
The inspection hole of the center wing is on the flight control compartment side. The cover of this hole is secured by screws, and is pressure-sealed with sealing material.

NOTE: As to the warning system, refer to Section 6.6 Stairway System.



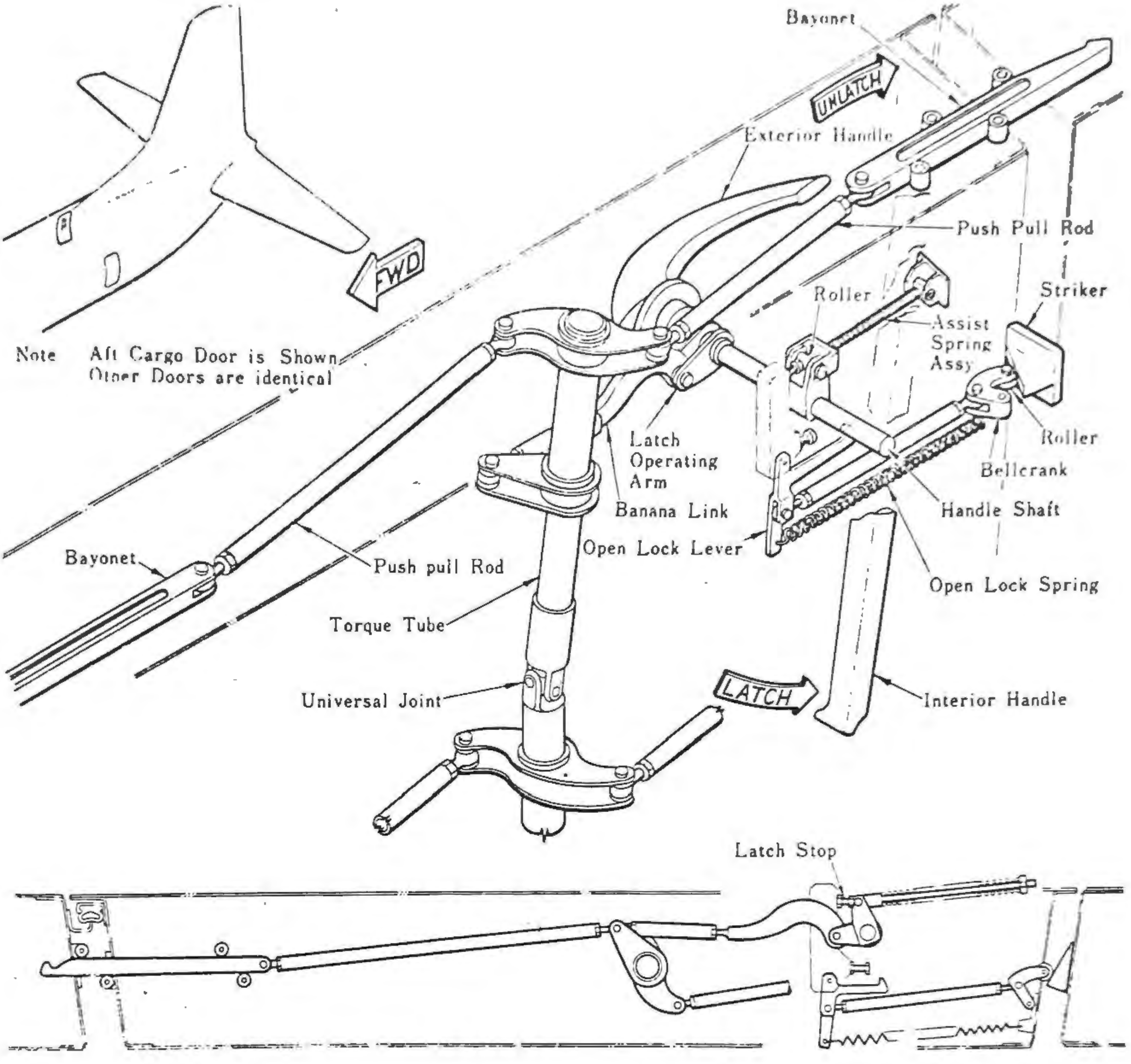
Fuselage Door

Figure 2-28

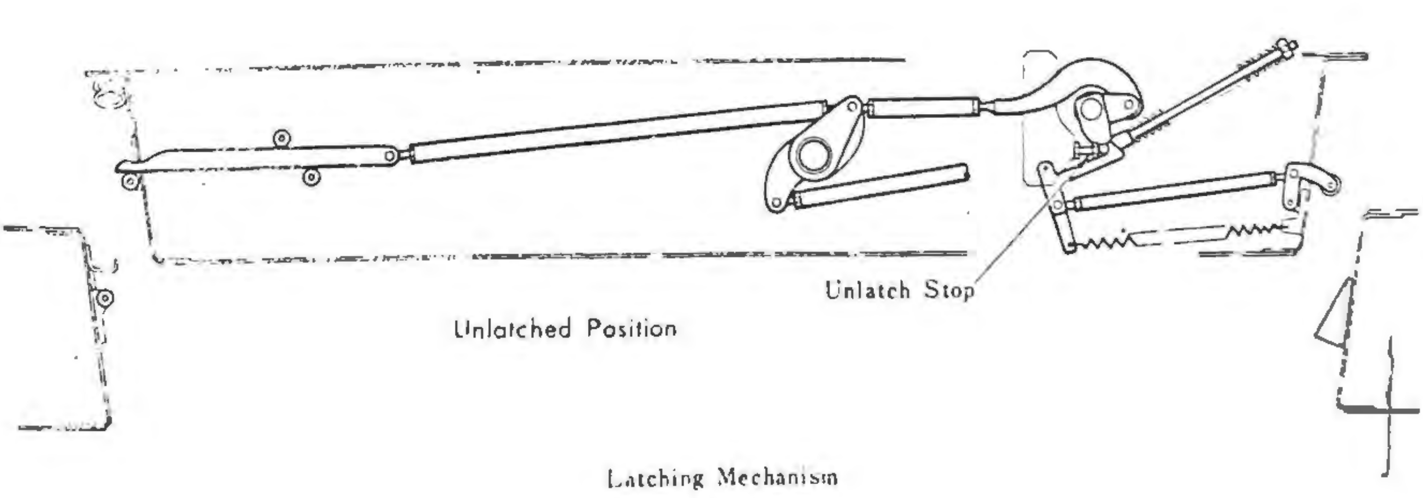

Seal
Latching Mech and Handle Open Lock Feature (Ref to 52-11-0)
Hinge Mechanism (Ref to 52-11-0)
Window
Hold Open Mechanism (Ref to 52-11-0)
Door Lining (FRP)
Washer
Screw
Pressure Lock (Ref to 52-11-0)
Roller Bracket

Galley Service Door

Figure 2-29



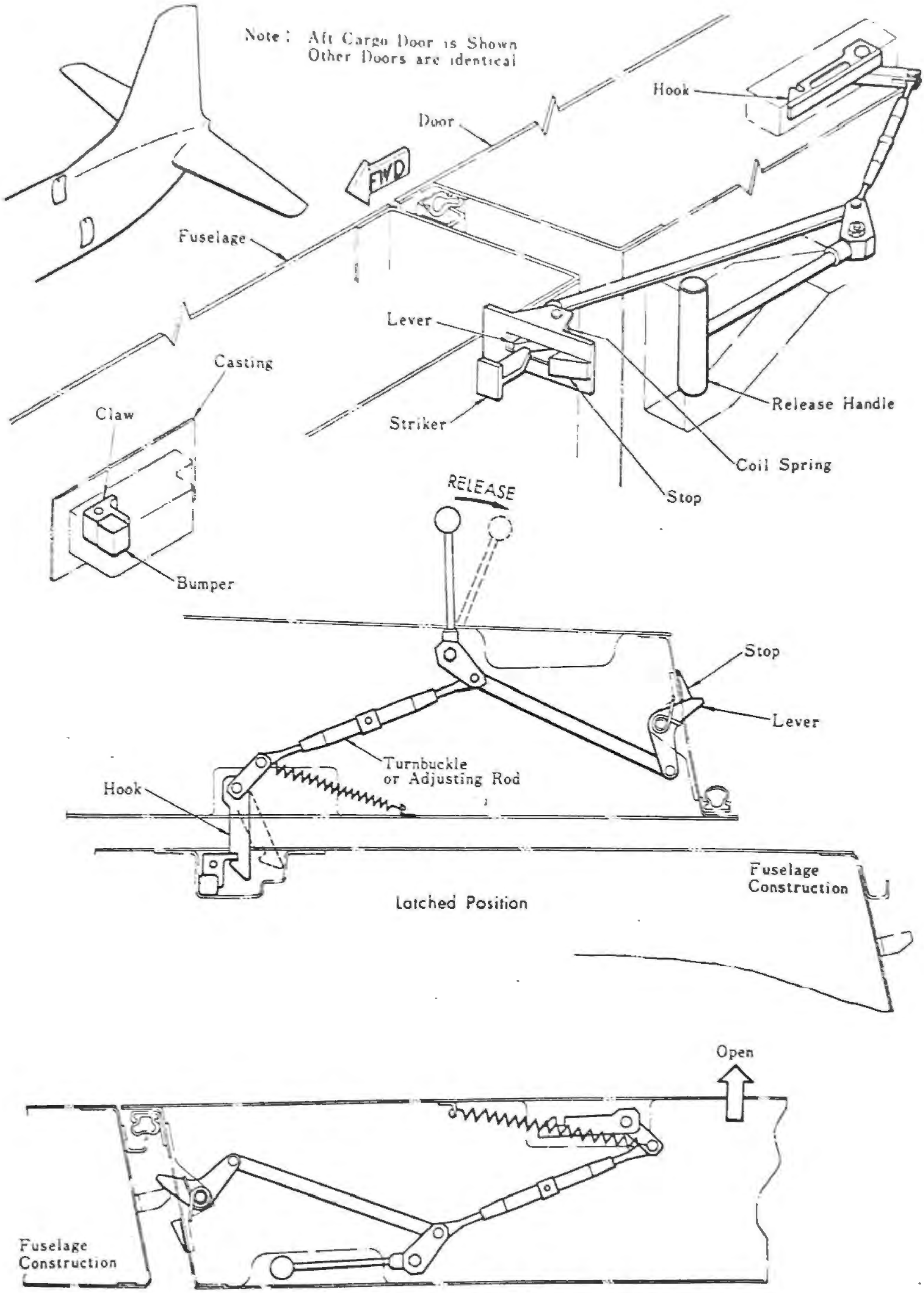
Latched Position



Unlatched Position

Latching Mechanism

Figure 2-30

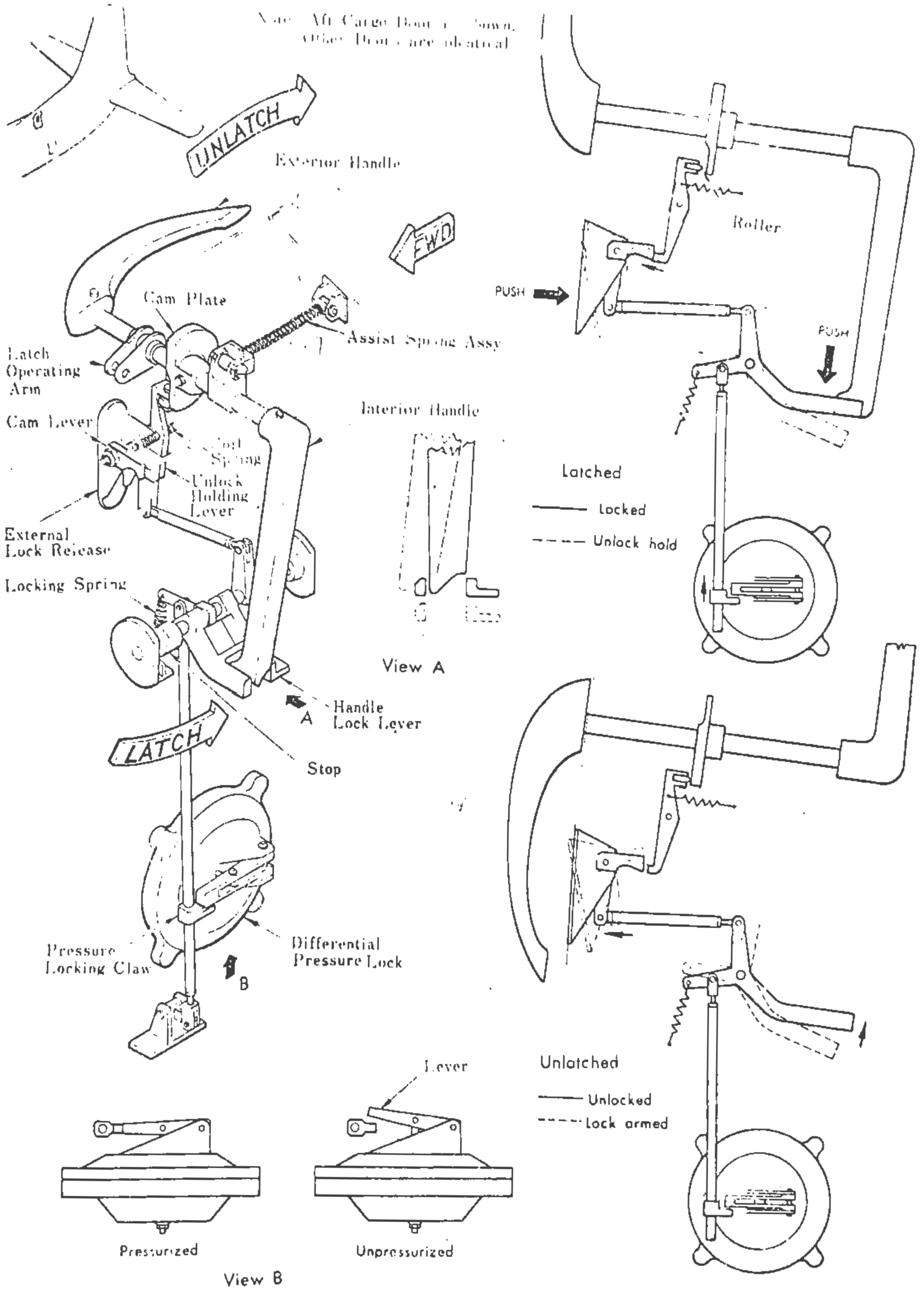


Latched Position

Door Closed Position

Hold Open Mechanism-Door

Figure 2-31



Pressure Lock Mechanism

Figure 2-32

2.7 Windows

The windows are classified into cockpit windows and cabin windows. The former are forward windshield, sliding window shield and aft windshield.

The number of the latter, including emergency exits, is 25 on the L.H. side and 26 on the R.H. side. A small round window is provided above each door.

2.7.1 Cockpit Windshield

Three kinds of cockpit windshields, six in all, are provided. The forward windshield is made of laminated reinforced glass panel with electroconductive coating inside the panel. The panel is heated for deicing and defogging and for protection against birds.

The sliding windshield consists of double panels, the outer panel being made of laminated reinforced glass; and the inside, acryl plastics. The air layer between the panels prevents the window from fogging. The windshield can be opened only when the compartment is not pressurized. Each windshield is explained below in some details:

(1) Forward Windshield

The forward windshield has sandwich structure with a vinyl layer placed between two reinforced glass panes.
The inside pane which is called the main ply, is 8 mm (0.312 in) thick fully tempered glass which serves as main structural member of the panel to withstand pressure.

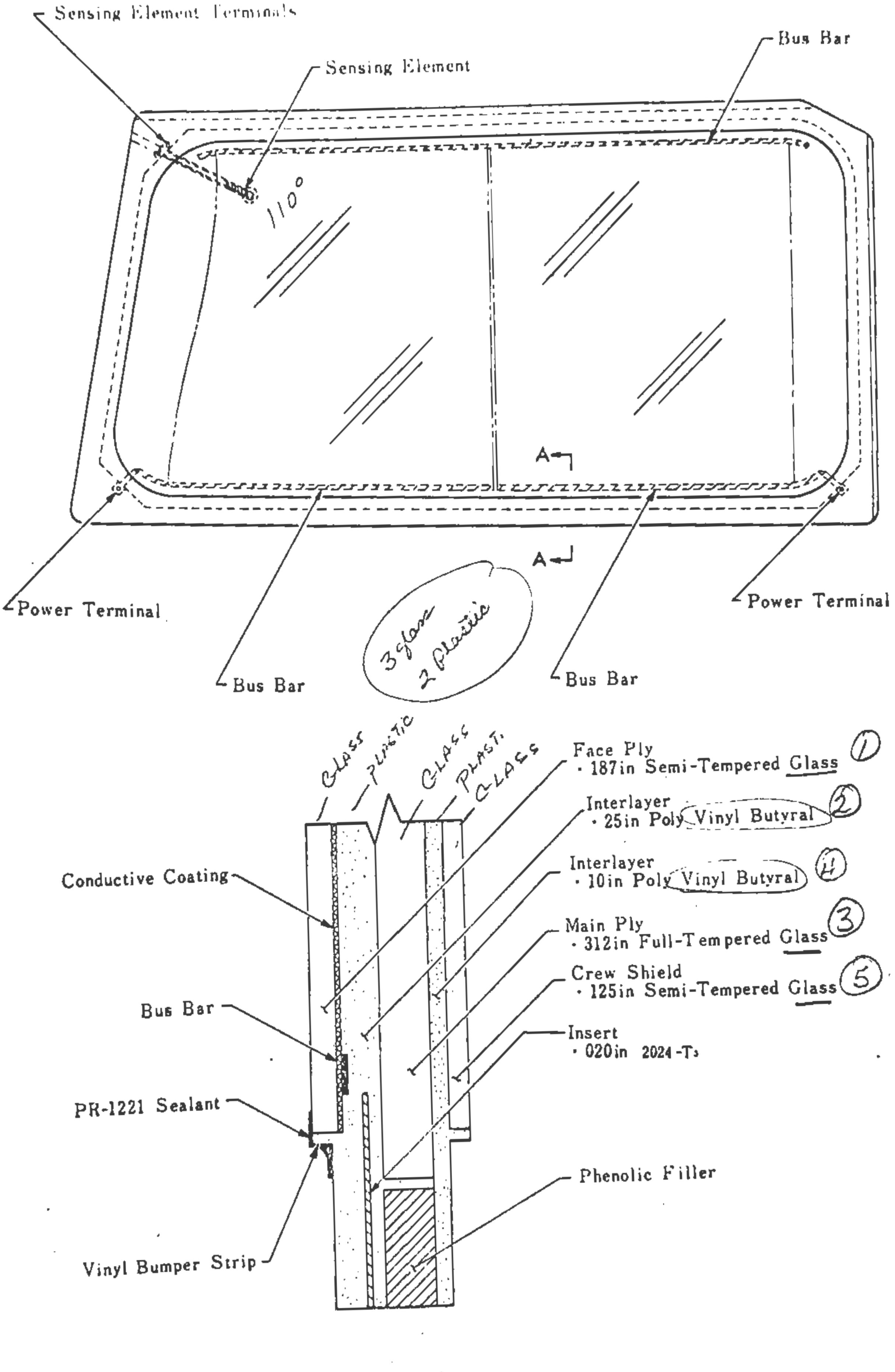
The inter-layer is 6mm(0.25 in) thick poly-vinyl butyral.
When a bird hits the window, the inter-layer serves as buffer, and prevents pieces of broken glass from scattering.

The outside pane which is, called the face ply, is 5 mm (0.187 in) semi-tempered glass with the inside coated to be electro-conductive. Bus bars are buried at the top and the bottom of the panel. If electric current is supplied to the coating, it is heated, deicing the panel and at the same time it gives plasticity to the interlayer to absorb shocks. Also, buried in the upper portion of the center side of the panels are sensing elements which keep temperature constant.

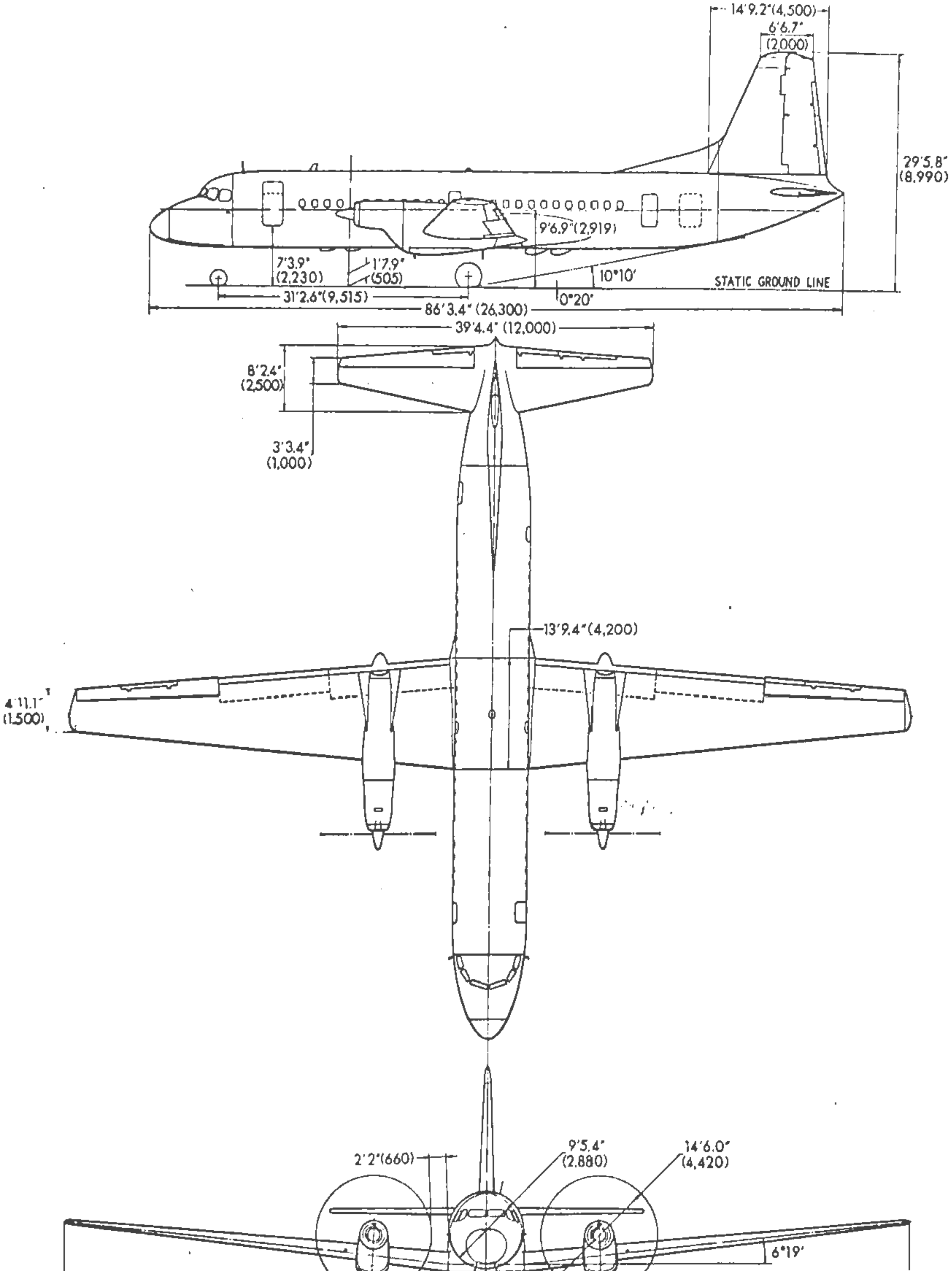
The panels are fixed in position with screws from the outside of the fuselage. For reinforcement, therefore, a 1 mm (0.040 in) insert is buried into the inter-layer. Also, aluminium alloy bushings are provided in the screw holes to prevent the layer from being damaged because of excessive overtightening.

(2) Sliding Windshield

The sliding windshield is of dual structure consisting of inner and outer panels.



Forward Windshield Panel
Figure 2-33



YS-11 Three View

Figure 1-1

1.4.4 Speed Limitation

			KT
Maximum Operating Limitation	below 13,600 ft	V_{mo}	245
	above 13,600 ft	M_{mo}	0.475
Operating Speed		V_A	154
Flap Extended Speed	Flap angle less than 10°	V_{fe}	200
	Flap angle less than 20°		165
	Flap angle less than 35°		135
Landing Gear Operating Speed	Down	V_{LO}	210
	Up		135
Landing Gear Extended Speed		V_{LE}	210
Landing Light Extended Speed			165

1.4.5 Towing Load

The supporting structure of each main landing gear has been designed for the limit towing load of 8,294 lbs (3,762 Kg).

1.4.6 Jacking Load

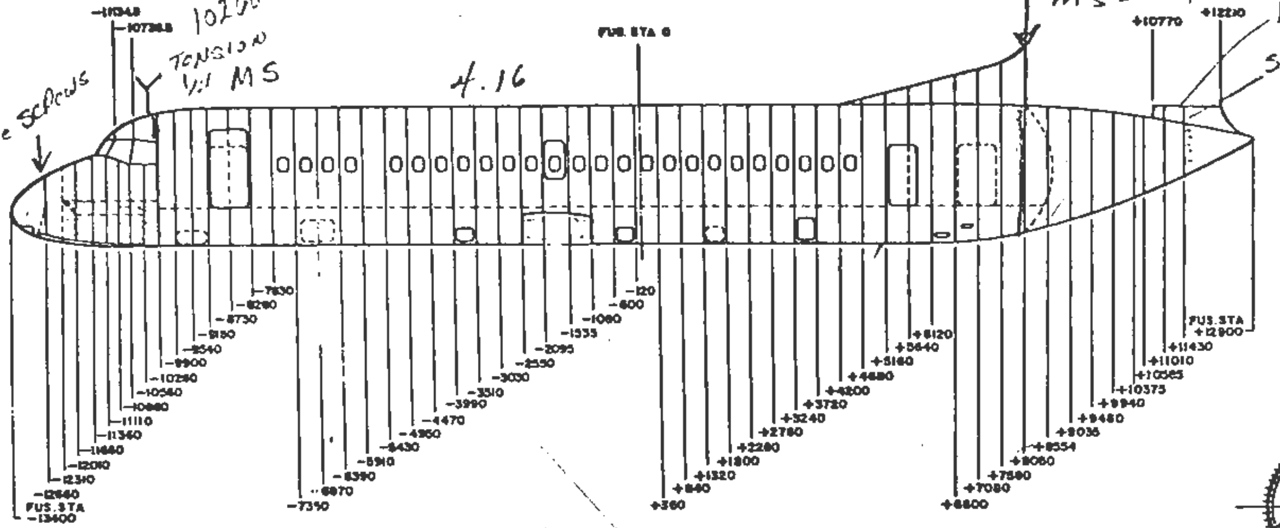
The structures around the jacking points have been designed to be able to support the aircraft weight of 54,010 lbs (24,500 Kg).

1.4.7 Cabin Pressure Load

Each section of the pressurized fuselage has been designed for the normal operating pressure of 4.16 psi which corresponds to the cabin altitude of 8,000 ft at the flight altitude of 20,000 ft.

1.4.8 Floor Loading and Allowable Weight of Passengers and Cargo Loading of Fuselage Floor

Item		Floor Loading lbs/ft^2 (Kg/m^2)	Allowable Cargo Weights lbs (Kg)
Cabin	75 (366)	75 (366)	
Forward Cargo Comp't (RH)	52 seats 38" pitch	100 (488)	1,500 (680)
	52 seats 34" pitch		2,500 (1,134)
	60 seats 34" pitch		1,200 (545)
Forward Cargo Comp't (LH)	52 seats 34" pitch	100 (488)	1,000 (454)
Aft Cargo Comp't		100 (488)	2,000 (908)
Belly Cargo Comp't		65 (317)	1,100 (500)



Fuselage

Pressure SCREWS

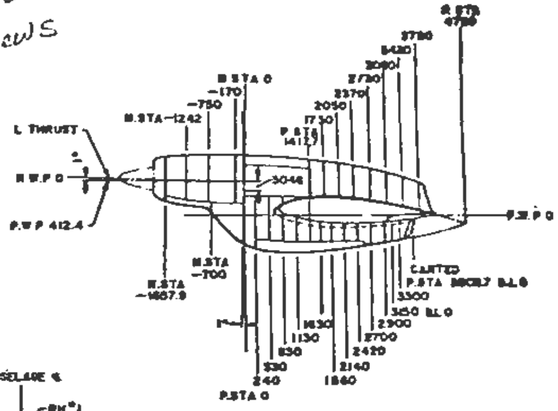
10260 TENSION 1/1 MS

DARK NOT PRESS

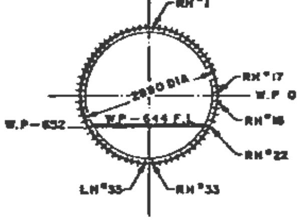
4.16

1/4 TENSION +8080 MS 20001

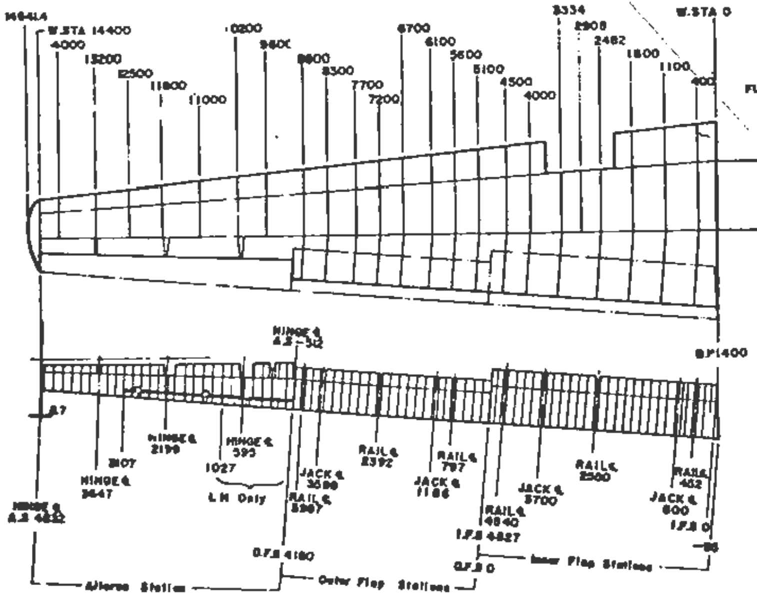
11430 SCREWS



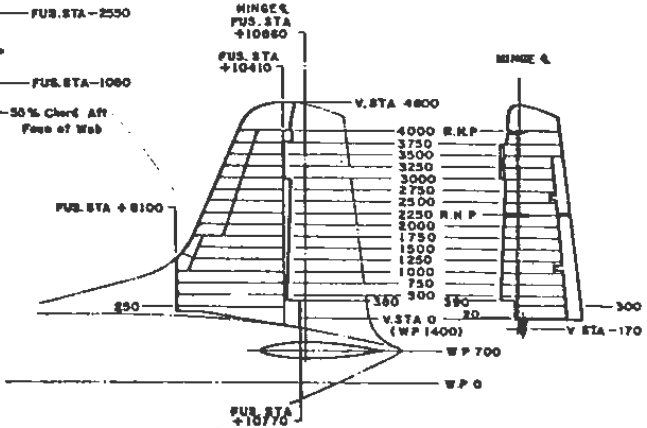
Nacelle



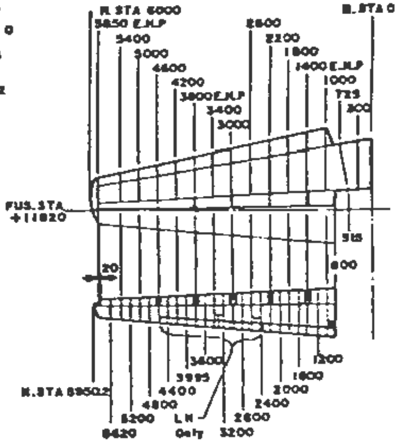
Typical Fuselage Cross Section
(STA-8260～STA+5160)



Outer Wing, Wing Flap & Aileron



Vertical Stabilizer & Rudder



Horizontal Stabilizer & Elevator

FUS · STA --- Fuselage Station
W · STA --- Wing Station
N · STA --- Nacelle Station
P · STA --- Power Plant Station
I F STA --- Inboard Flap Station
O-F · STA --- Outboard Flap Station
A · STA --- Aileron Station
H · STA --- Horizontal Stabilizer Station
V · STA --- Vertical Stabilizer Station
W · P ----- Water Plane
B · P ----- Buttock Plane
R · H · P ----- Rudder Hinge Point
N W · P ----- Nacelle Water Plane
P · W · P ----- Power Plant Water Plane
E · H P ----- Elevator Hinge Point

Station Diagram
Figure 2-1

2.2 Structure of Fuselage

2.2.1 General

The fuselage has stressed-skin structure, consisting mainly of forward, mid and aft fuselages. These sections are joined at Sta -10260 and Sta +8080, with 1/4 inch tension bolts.

The forward end (Sta -12660 to Sta -13400) of the fuselage is a nose cap or radome which is installed with hinges for easy removal and installation.

The section between Sta -8280 and Sta +6120 of the mid fuselage has a uniformly round cross-section, 2,880 mm in diameter. The frames in this section, except a few, are spaced at an interval of 480 mm. In the section between Sta -2550 and -1080, the center wing is attached to the fuselage permanently.

The section between Sta +11430 and Sta +12900 is a tail cone attached to the fuselage with screws.

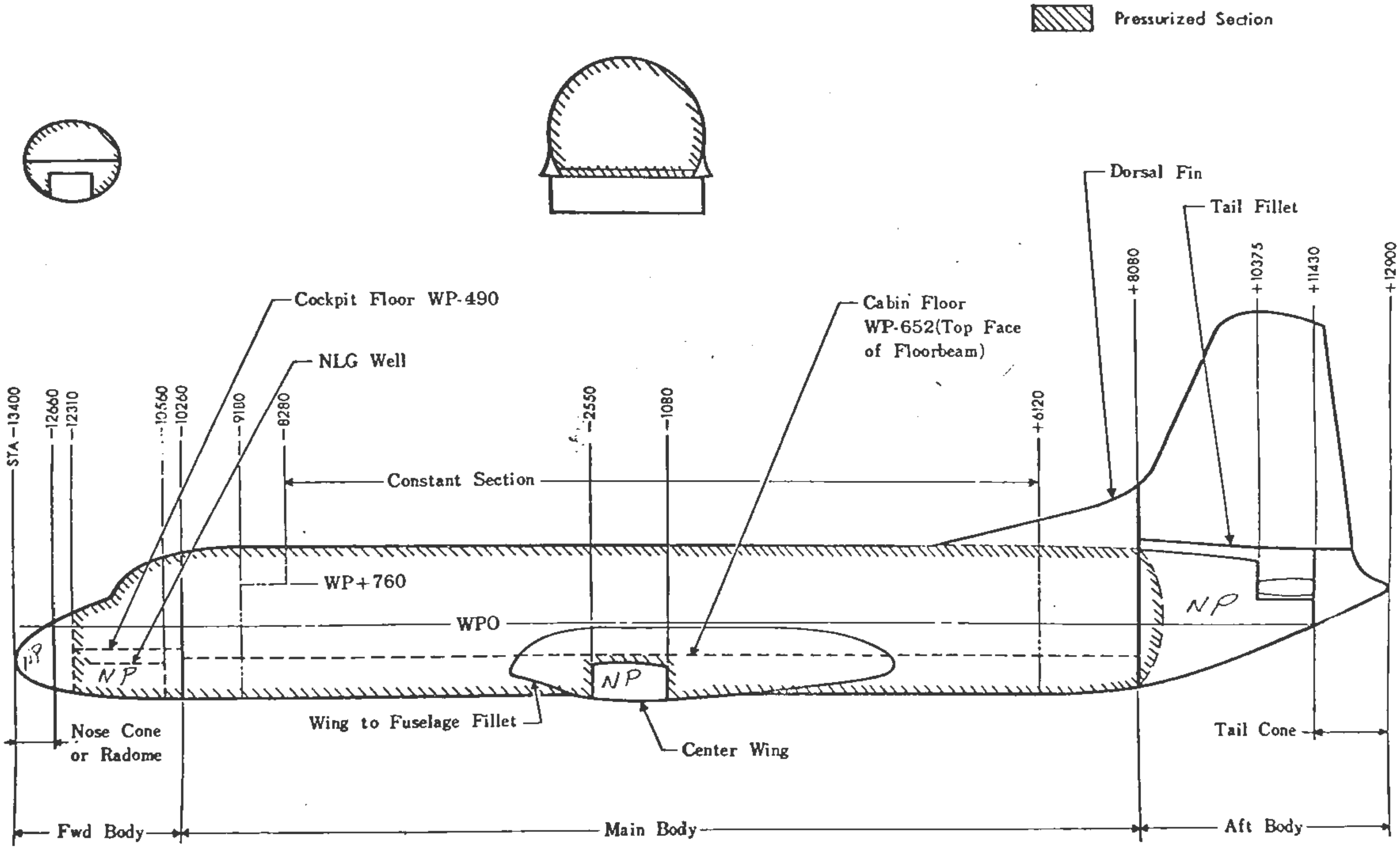
The section between Sta -12310 and Sta +8080, except the nose gear wheel well and the center wing, is pressure-sealed and can be pressurized to the normal operating pressure of 4.16 psi. The pressurized area is divided by the floor into upper and lower sections. The underfloor section is divided into the following five sub-sections: from fore to aft, electrical compartment (Sta -10560 to Sta -8280), underfloor baggage compartment (Sta -8280 to Sta -3990), flight control compartment (Sta -3990 to Sta -2550), hydraulic compartment (Sta -1080 to Sta +360) and air conditioning compartment (Sta +360 to Sta +5160). Each of these compartments has a door which can be opened and closed from outside the plane. Ice plates are attached to those portions of fuselage skin which are adjacent to the propellers.

The fuselage structure mainly consists of frames, stringers and skin, which are secured by shear ties and clips.

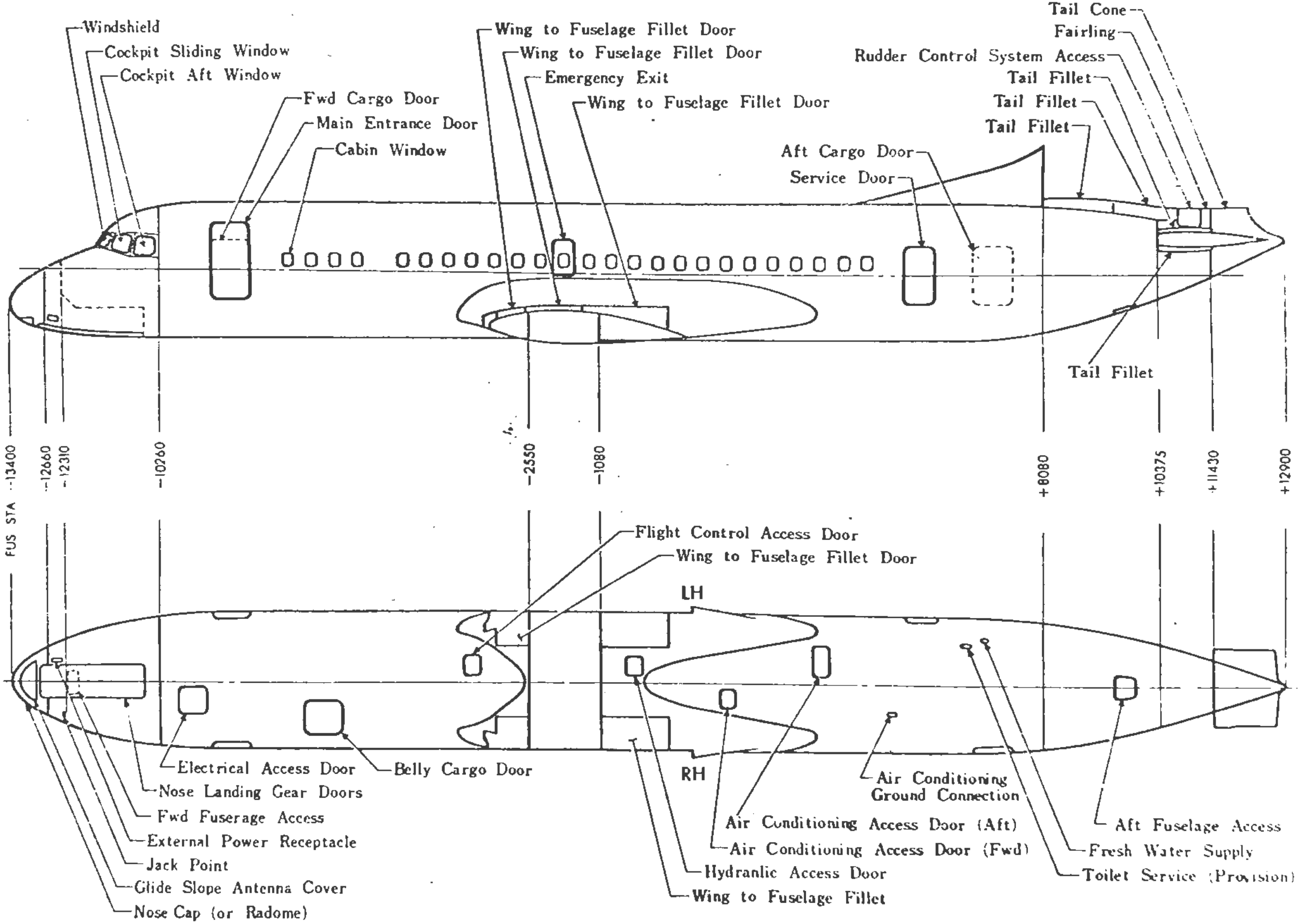
The sealing material for the pressurized section of the fuselage is mainly PR-1222. The butt ends of the skin, such as those at the fuselage joint sections, are waterproofed with sealing material PR-341.

2.2.2 Material for Fuselage Structure

The fuselage is of such construction that longerons are installed around the frames and covered by the skin. The skin is reveted to the frames (through shear ties) and to the longerons. For riveting, MS20426 AD flush head rivets are mostly used.

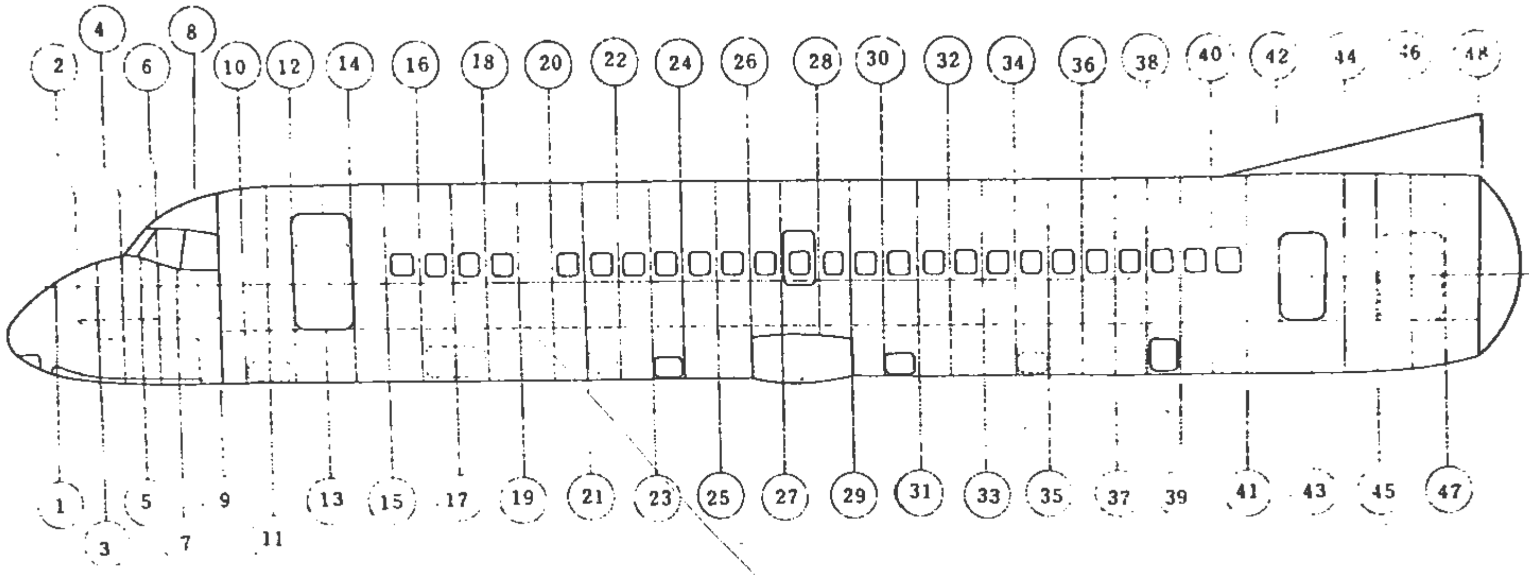


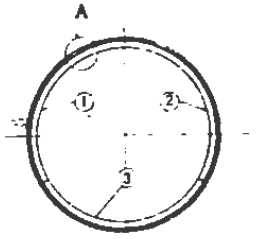
Fuselage Structure Assembly
Figure 2-4



Fuselage Station, Windows, Doors and Access Provisions

Figure 2-7

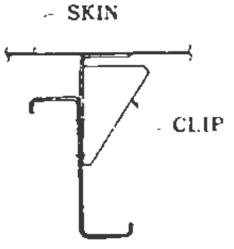




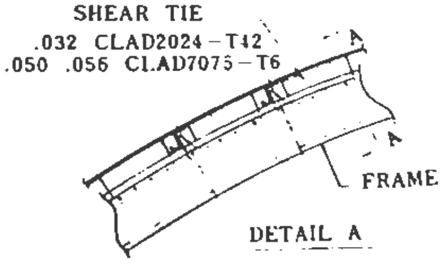
TYPICAL FRAME SECTION

ITEM	STATION	GAGE	
		① ②	③
1	−12660	.050	
2	−12310	.056	
3	−12010	.050	
4	−11660	.063	
5	−11360	.063	
6	−11110	.050	
7	−10860	.063	
8	−10560	.056	
9	−10260	.056	
10	−9900	.050	.056
11	−9540	.050	.056
12	−9180	.056	
13	−8730	.050	.056
14	−8280	.056	
15	−7830	.050	.056
16	−7350	.050	.056
17	−6870	.050	.056
18	-6390	.050	.056
19	−5910	.050	.056
20	−5430	.050	.056
21	−4950	.050	.056
22	−4470	.050	.056
23	−3990	.050	.056
24	−3510	.050	.056
25	−3030	.050	.056
26	−2550	K2018 56	
27	−2095	.050	.056
28	−1535	.050	.056
29	−1080	K2018	
30	−600	.050	.056
31	−120	.050	.056
32	+360	.050	.056
33	+840	.050	.056
34	+1320	.050	.056
35	+1800	.050	.056
36	+2280	.050	.056
37	+2760	.050	.056
38	+3240	.050	.056
39	+3720	.050	.056
40	+4200	.050	.056
41	+4680	.050	.056
42	+5160	.050	.056
43	+5640	.050	.056
44	+6120	.050	.056
45	+6600	.050	.056
46	+7080	.050	.056
47	+7580	.050	.056
48	+8080	.056	

NOTE : ALL MATERIALS ARE CLAD7075 – T6



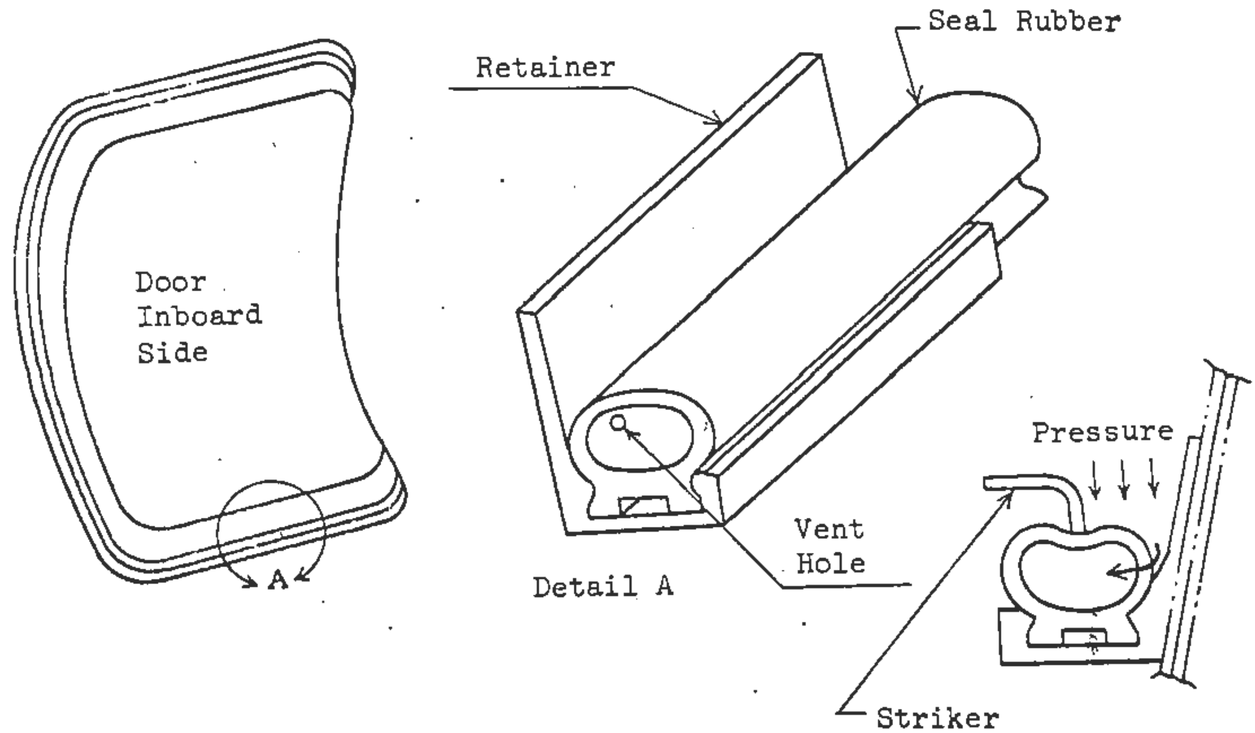
SECTION A – A



DETAIL A

Frame Materials – General

Figure 2-9



Door Seal

Figure 2-27

a. Outer Panel

This panel is of dual structure with a vinyl layer placed between two reinforced glass panels. Material of each layer is as follows:

Face ply:	0.125 inch semi-tempered glass
Inter-layer:	0.200 inch poly-vinyl butyral
Main ply:	0.250 inch fully tempered glass

b. Inner Panel

This panel is 0.250 inch thick acryl plastic material. Conditioned air in the cockpit enters the portion between the aforesaid two panels through a moisture absorbing device using silica gel, defogging the windshield and insulating heat.

The sliding windshield moves on rollers along the track. In emergency, it can be opened from outside the aircraft.

(3) Aft Windshield

The aft windshield, made of acryl plastic material, is of a dual structure, composed of outer and inner panels 0.500 inch thick each. Cockpit air enters the portion between the two panels through the silica gel desiccator.

Rubber bushings are provided in the panel mounting screw holes to take the relative motion of the fuselage structure and the window and to serve as sealing.

2.7.2 Cabin Windows

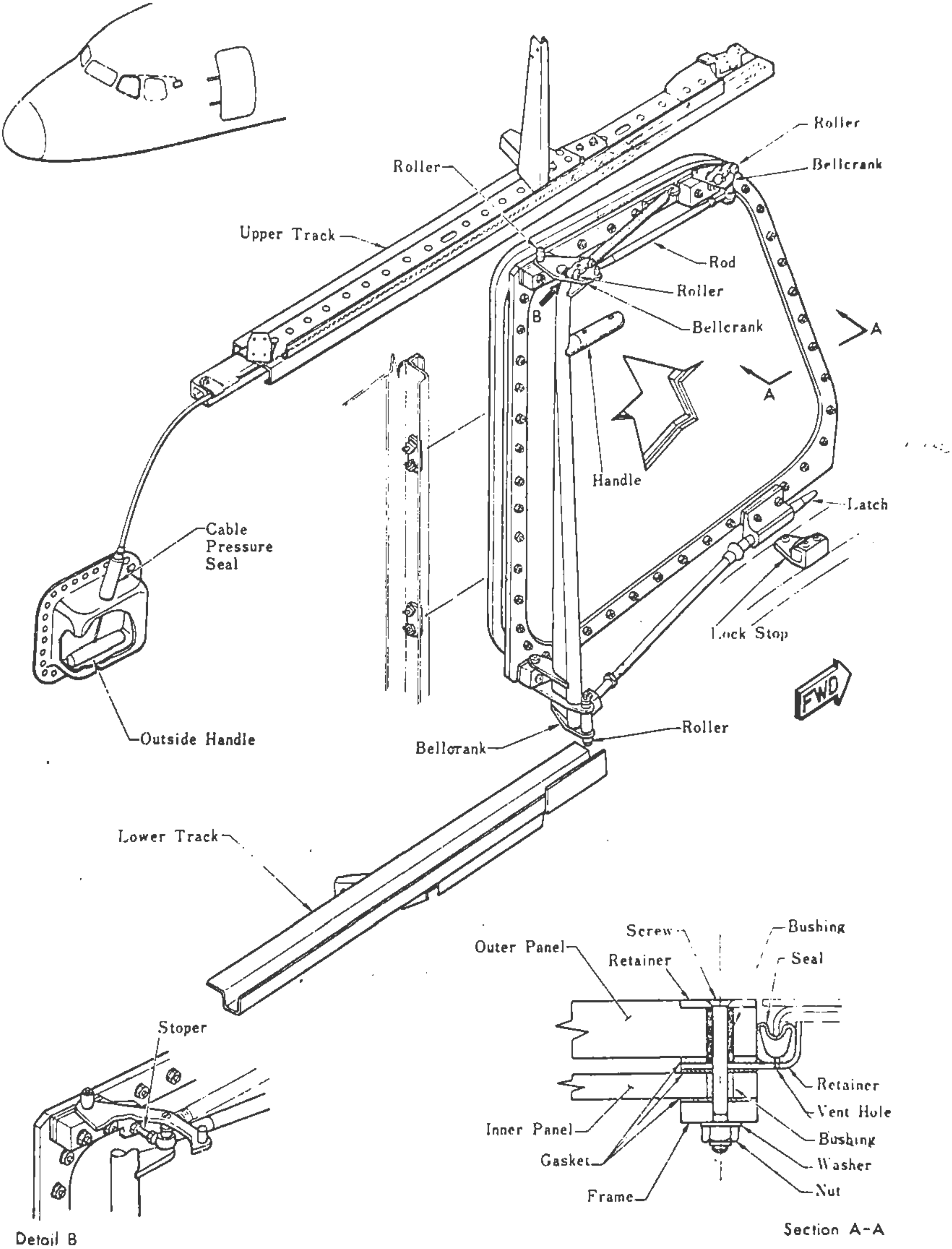
In the cabin, there are 25 L.H. and 26 R.H. windows, each 240 mm wide and 320mm high.
The cabin window is of dual structure consisting of outer and inner panels which are 5 mm thick acryl plastic panes. The air layer, which is formed by spacers made of the same material as the panels, defogs the window and provides heat insulation for the cabin.

The aforesaid air layer is connected to the vinyl bag of the desiccator through the silica gel-filled vinyl tube for desiccation which is in the lower part of the window.

As the vinyl bag transmits the cabin pressure to the air inside, ordinarily, the outer panel takes the cabin pressure.

A single outer panel or a single inner panel is strong enough to withstand the cabin pressure.

The window is fixed to the fuselage structure with screws. Rubber bushings are provided in the screw holes to take the relative motion of the airframe and the window and to serve as sealing.



Sliding Windshield

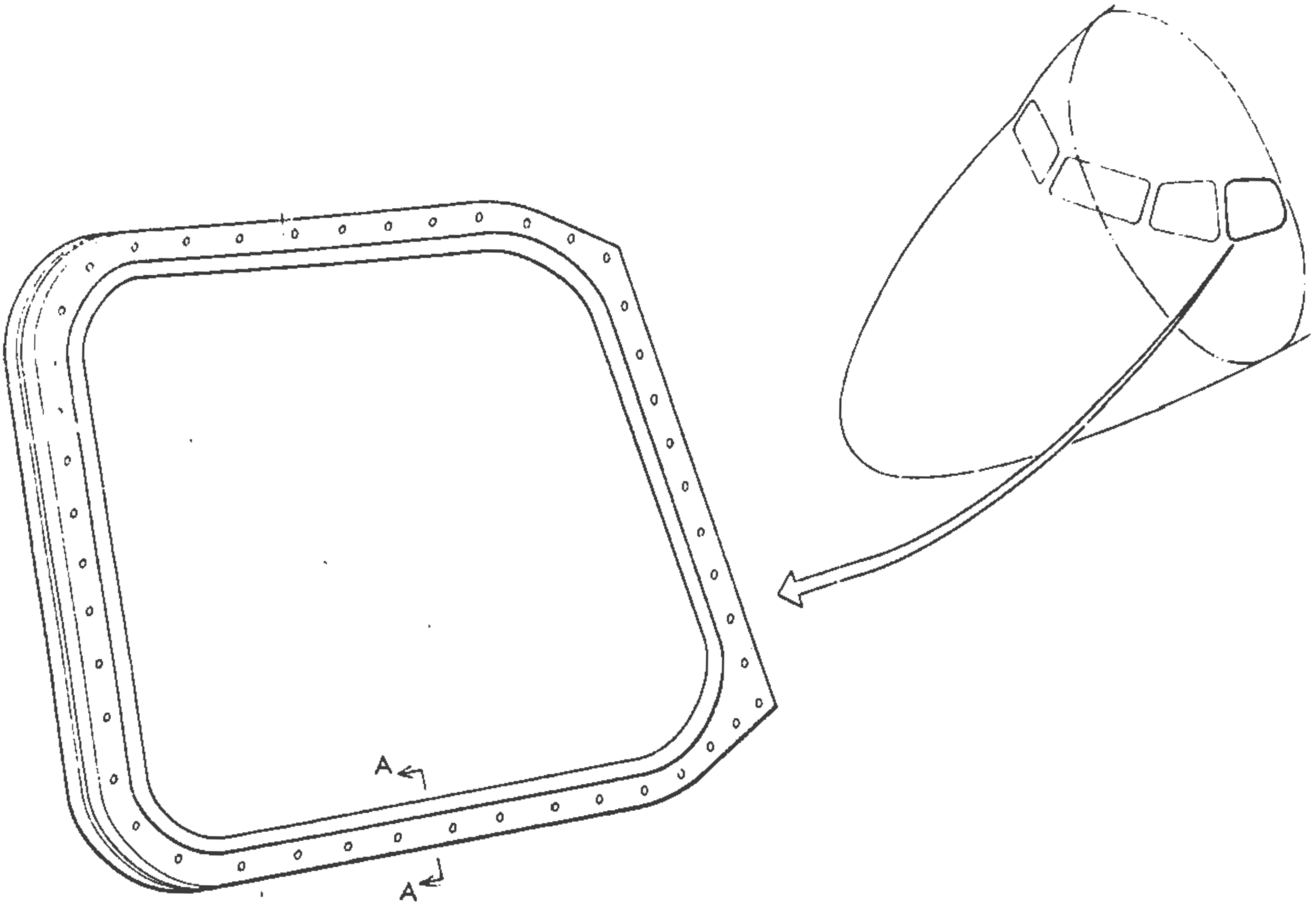
Figure 2-34

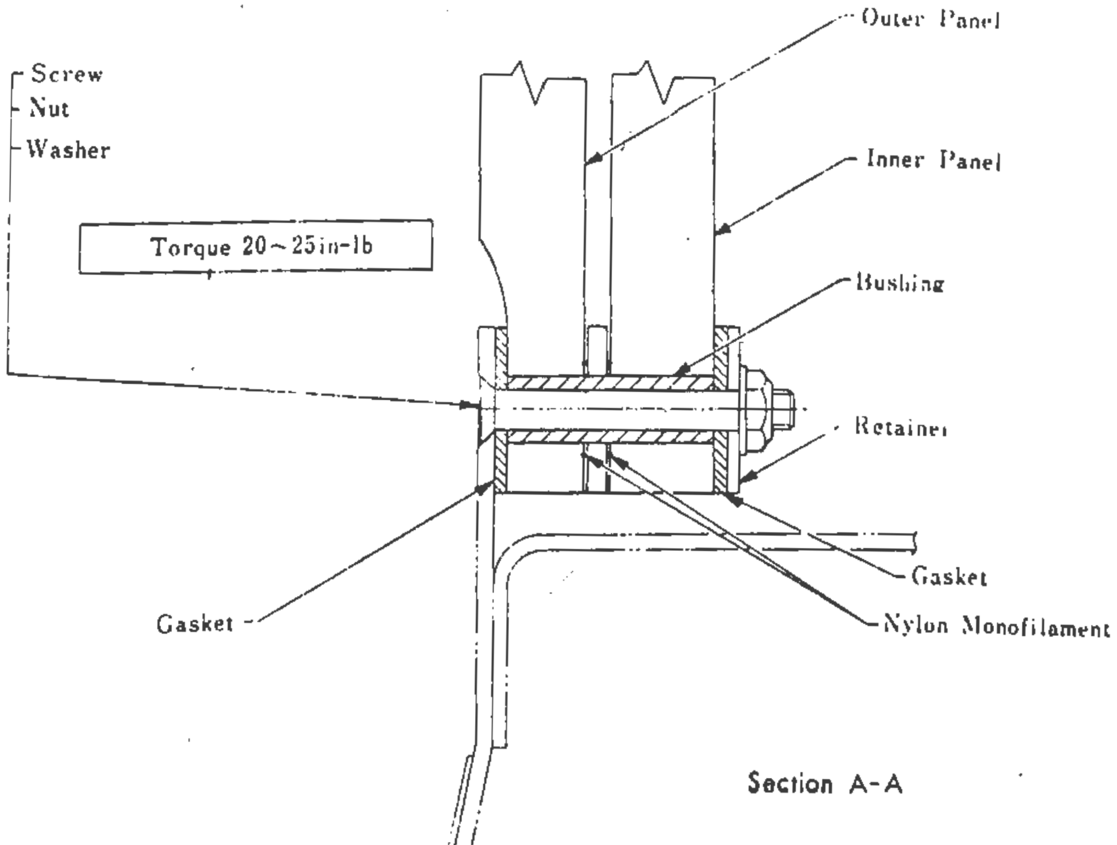
2.7.3 Door Windows

Each of the service door and the aft cargo door has a round window, 140 mm in diameter, on the upper part.

Those windows have double structure of acryl plastic material 3 mm thick. They are fixed to the doors with screws.

No desiccator is provided in these windows.

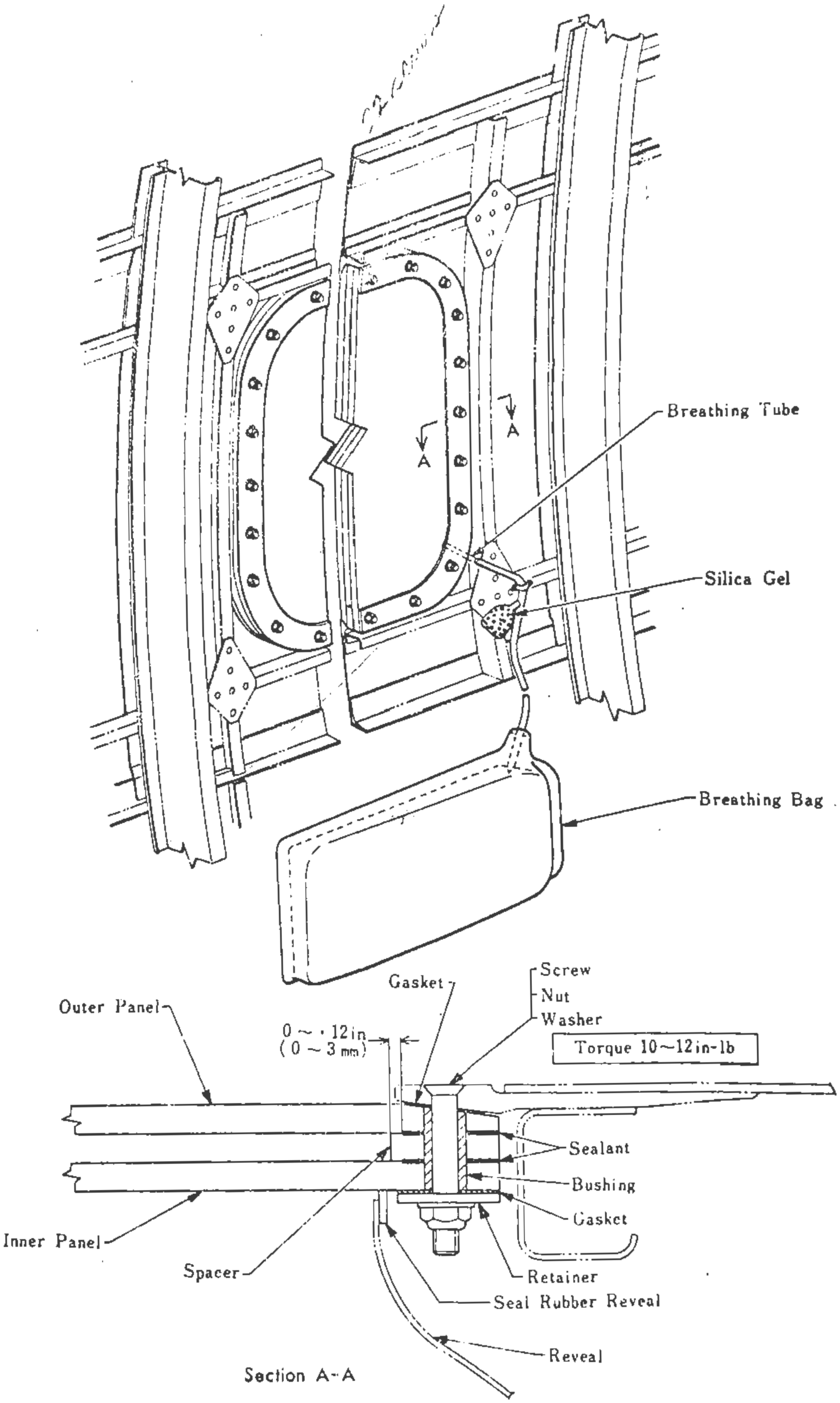




Section A-A

Side Windshield Installation

Figure 2-35



Cabin Window Installation

Figure 2-36

Chapter 3 LANDING GEAR

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Chapter 3 LANDING GEAR

3.1 General

The landing gear is of nose gear type and is operated by the landing gear control lever mounted on the center pedestal.

Extension and retraction of the gears are accomplished by the hydraulic actuating cylinders and the landing gear doors are opened and closed by door actuating mechanisms.

The landing gear is locked mechanically in their UP or DOWN position. Up-lock is normally released by hydraulic pressure, however, in case of failure of the hydraulic system, an emergency gear down system allows free fall of the gears.

Locking position of the gears is indicated by electrical indication system on the instrument panel in the cockpit. Furthermore, visual indicators are provided for visual check.

The main landing gear is of dual wheel type with the brake assembly and the nose landing gear is of co-rotating dual wheel type with the steering system.

Both normal and emergency brake systems are operated by hydraulic pressure, and an electrical anti-skid mechanism is provided in the normal brake system.

3.2 Main Landing Gear

3.2.1 Shock Strut

Left and right shock struts which look like the letter Y are interchangeable between them. The shock strut is mounted on the shock strut mounting fitting on the bottom surface of the wing with pins which are held in place by tie rods.

The shock strut consists of a cylinder and a piston, both connected each other with the torque arms.

Inside the cylinder a plunger tube is suspended from top and an orifice plate is provided at the end of the plunger tube. There are a metering pin and a recoil valve in the piston.

Impact load to the aircraft is controlled and absorbed by the orifice plate and the metering pin. The shock strut is so designed that it can be easily compressed and hardly extended due to the function of the recoil valve.

Filling ports for oil and air are located on the top of the strut. Oil MIL-H-5606A shall be used.
The gap between the cylinder and the piston is sealed with the "O" ring and back up ring packing.

Remove the gland nut at the lower part of the shock strut, and two spare "O" rings come out.

Therefore, replacement of "O" ring with spare one without pulling out the piston is permitted once only.

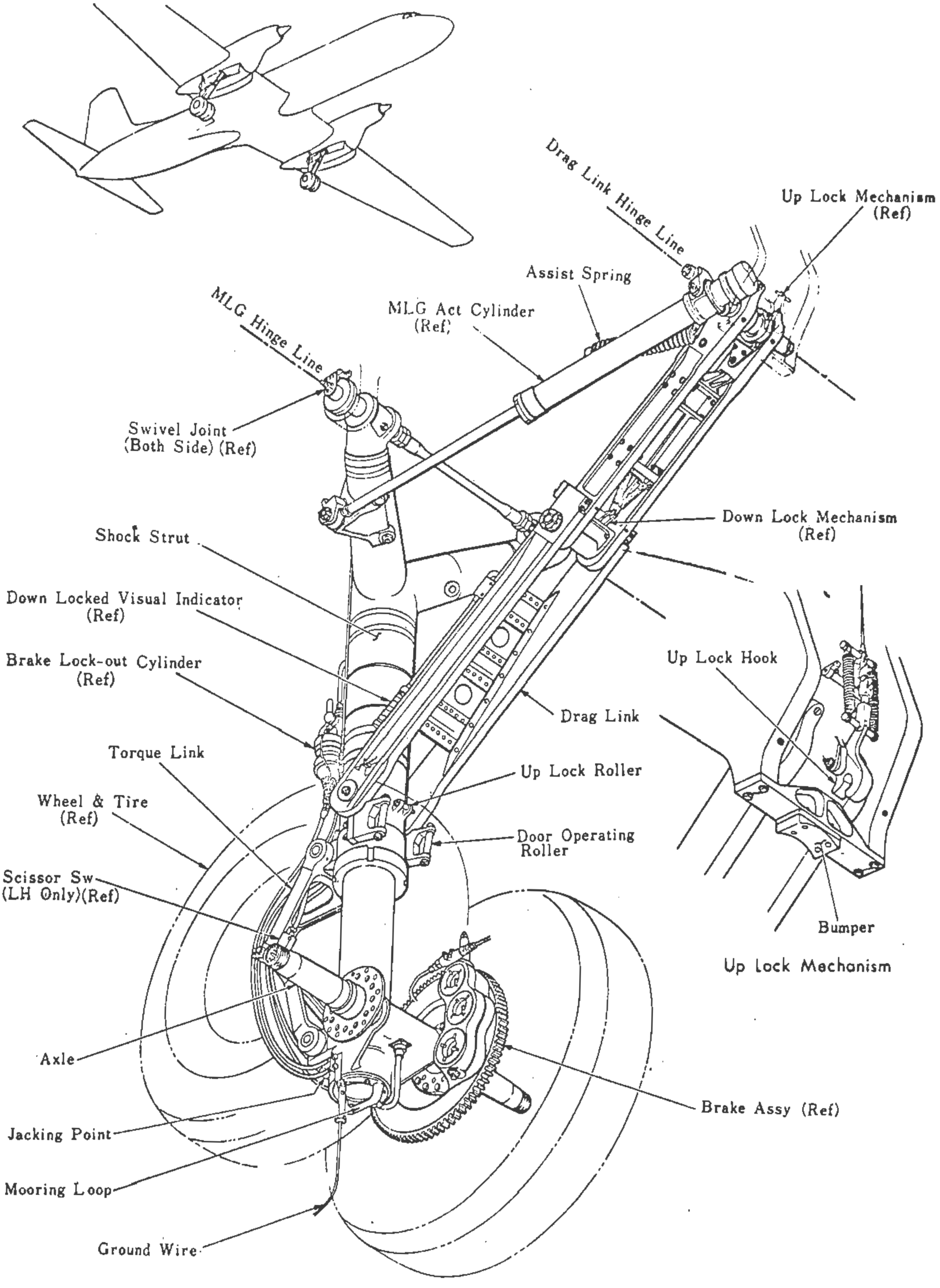
3.2.2 Drag Link

The drag link consisting of the upper and lower drag links is attached to the middle part of the shock strut and the lower part of the front spar of the main wing.

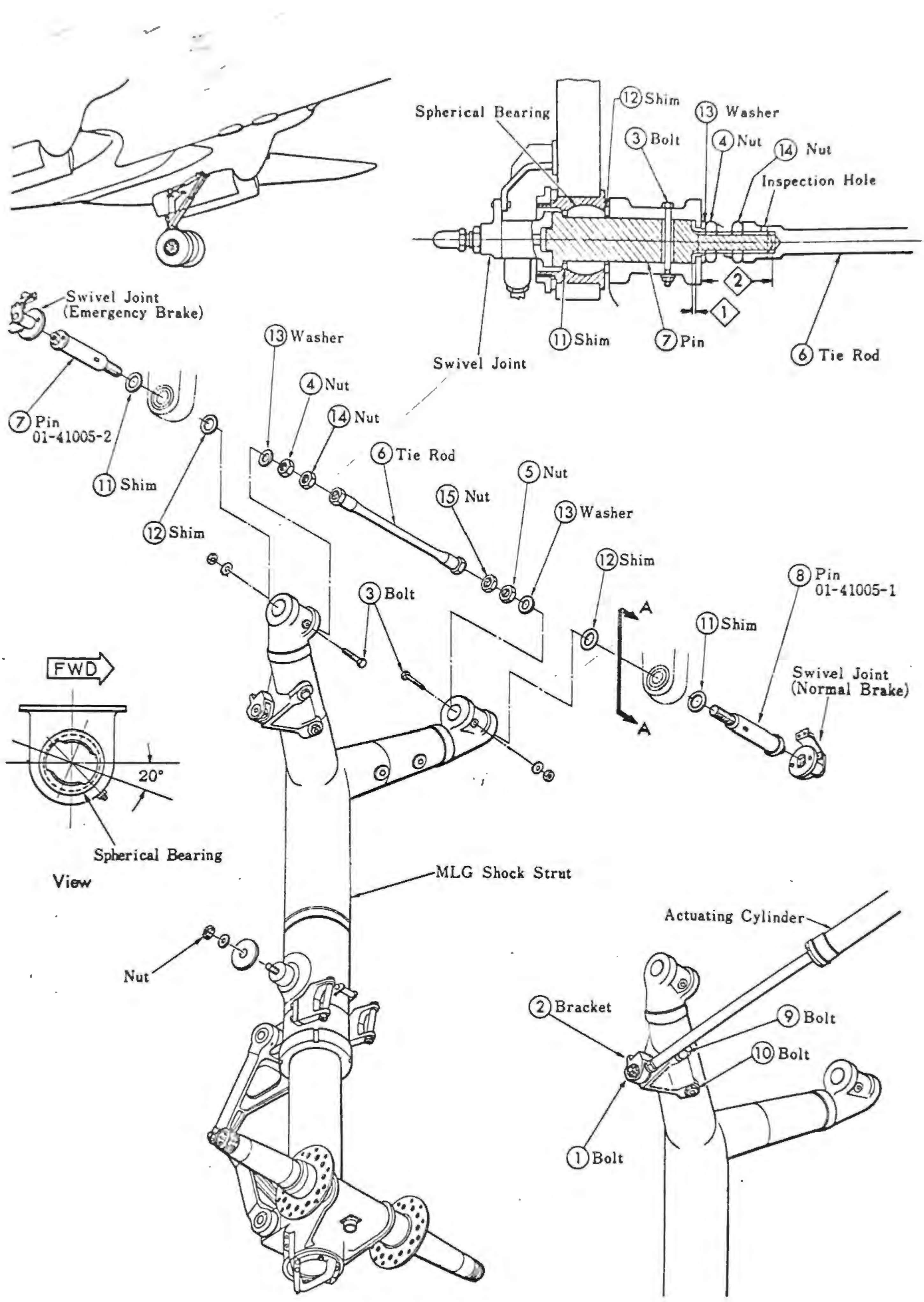
When the landing gear is extended, both links are in a straight line, on the other hand, when retracted they are folded rearwards at the joint.

At the joint section, is located a down-lock mechanism which locks the strut when the gear is extended.

To the shaft of the upper mounting section of the upper drag link, a gear actuating cylinder and an assist spring are mounted. Down-lock indication system is installed on the lower drag link.

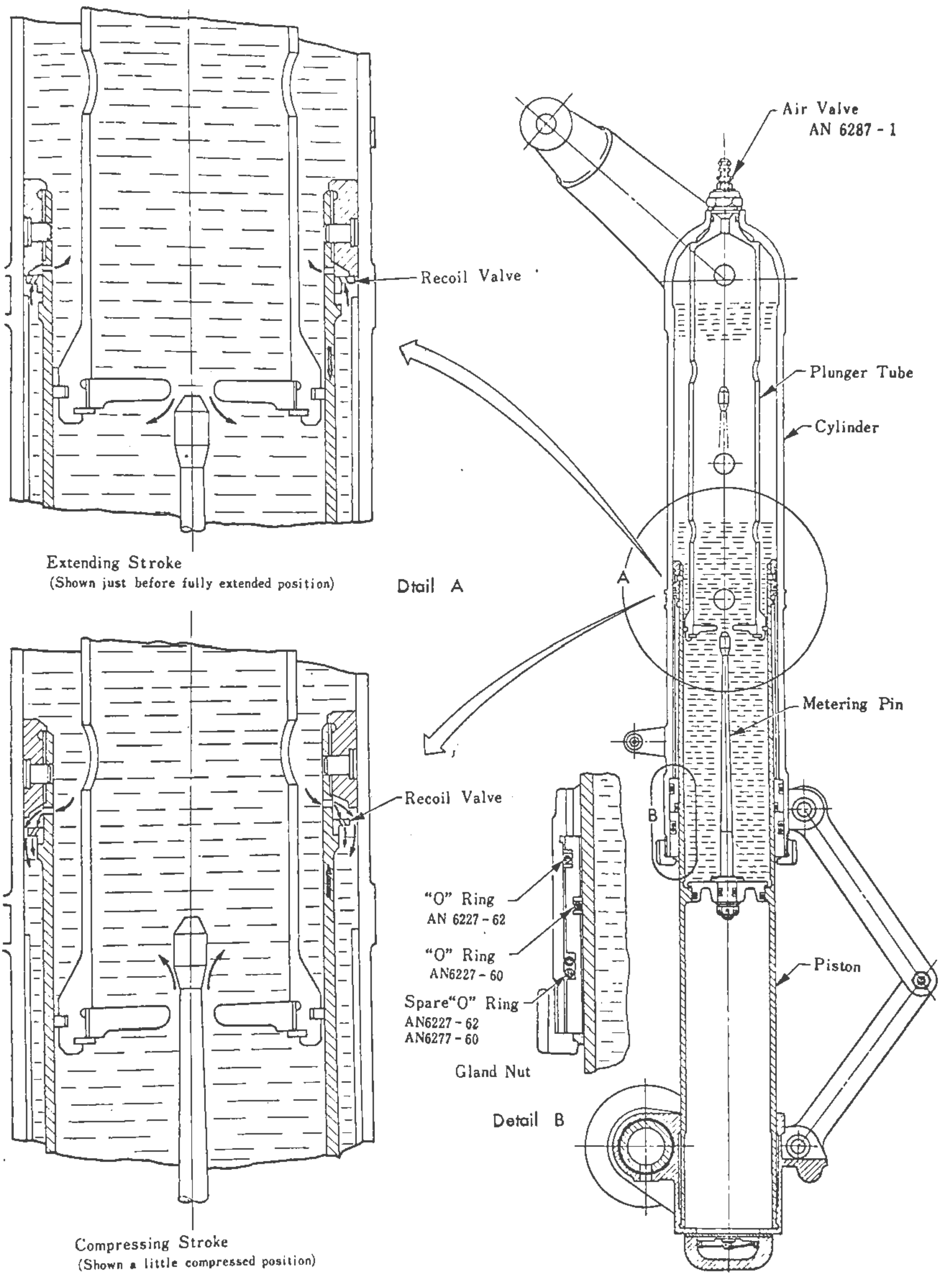


Main Landing Gear
Figure 3–1



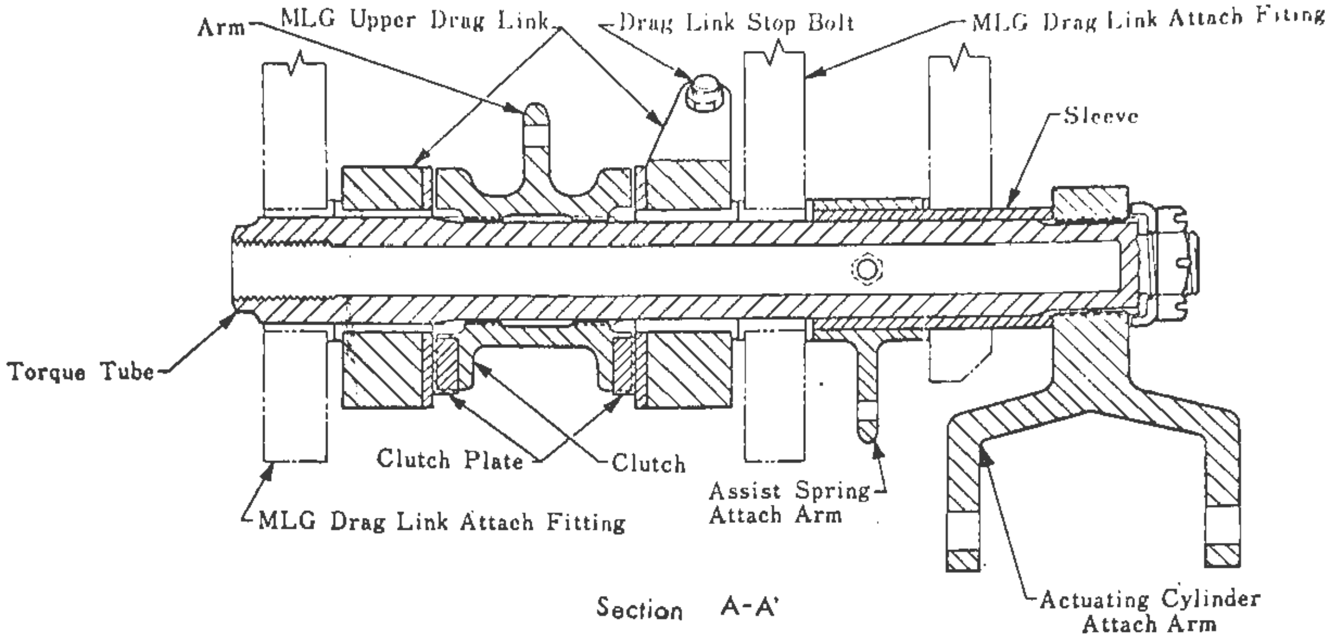
Main Landing Gear Shock Strut Remove/Install

Figure 3–2

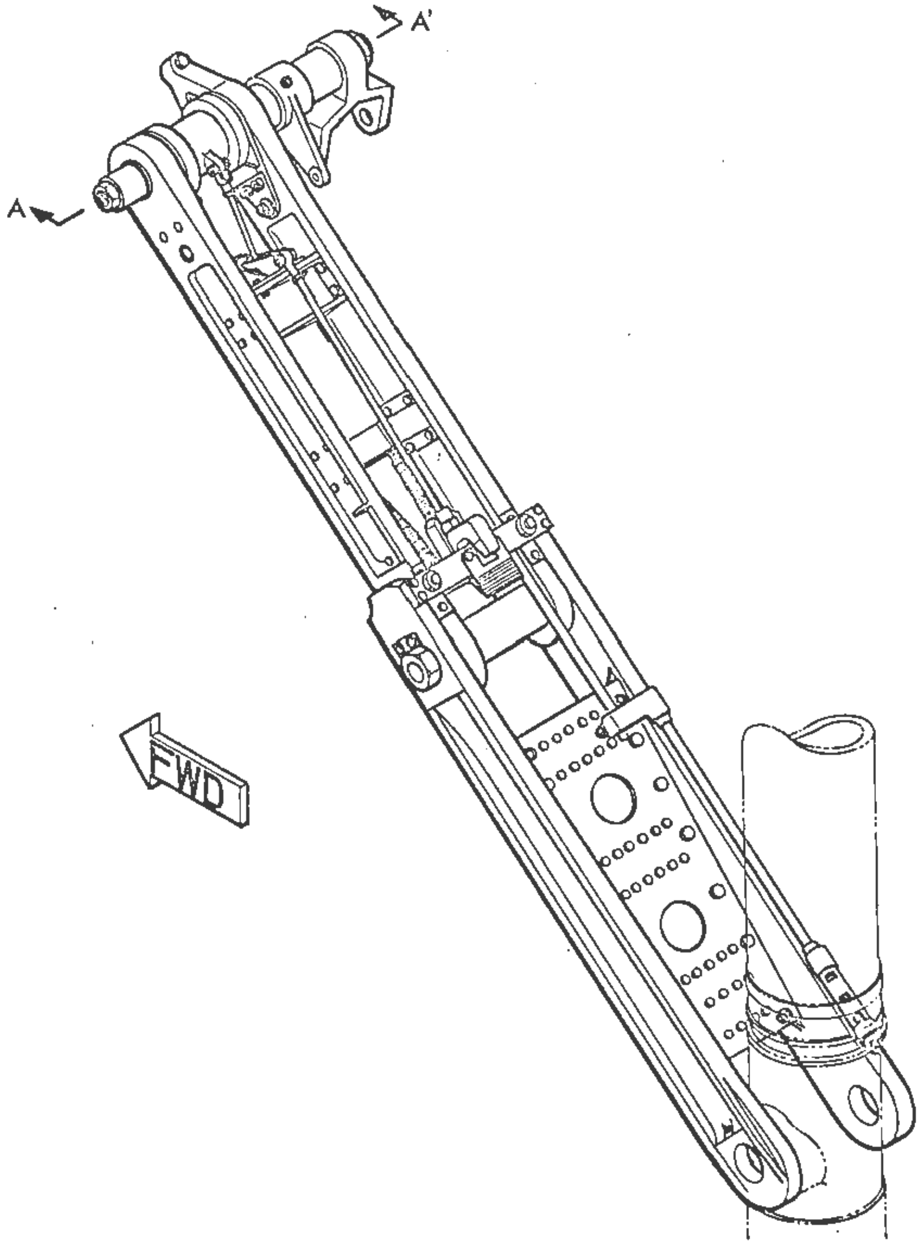


Main Landing Gear Shock Strut

Figure 3–3



Section A-A'



Main Landing Gear Drag Link

Figure 3–4

3.3 Nose Landing Gear

3.3.1 Shock Strut

To the T-shaped shock strut, the left and right side-struts are attached. Both ends of T-shaped strut are attached to the FUS STA-10860 fittings which can be separated into upper and lower parts.

Main difference from the main landing gear is a built-in centering cam which makes the wheel face front properly when the piston of the shock strut is fully extended.

The filling ports for air and oil are located on the top of the shock strut. Oil, MIL-H-5606A shall be used.

The spare "O" rings are also contained inside like the main gear.

3.3.2 Drag Link

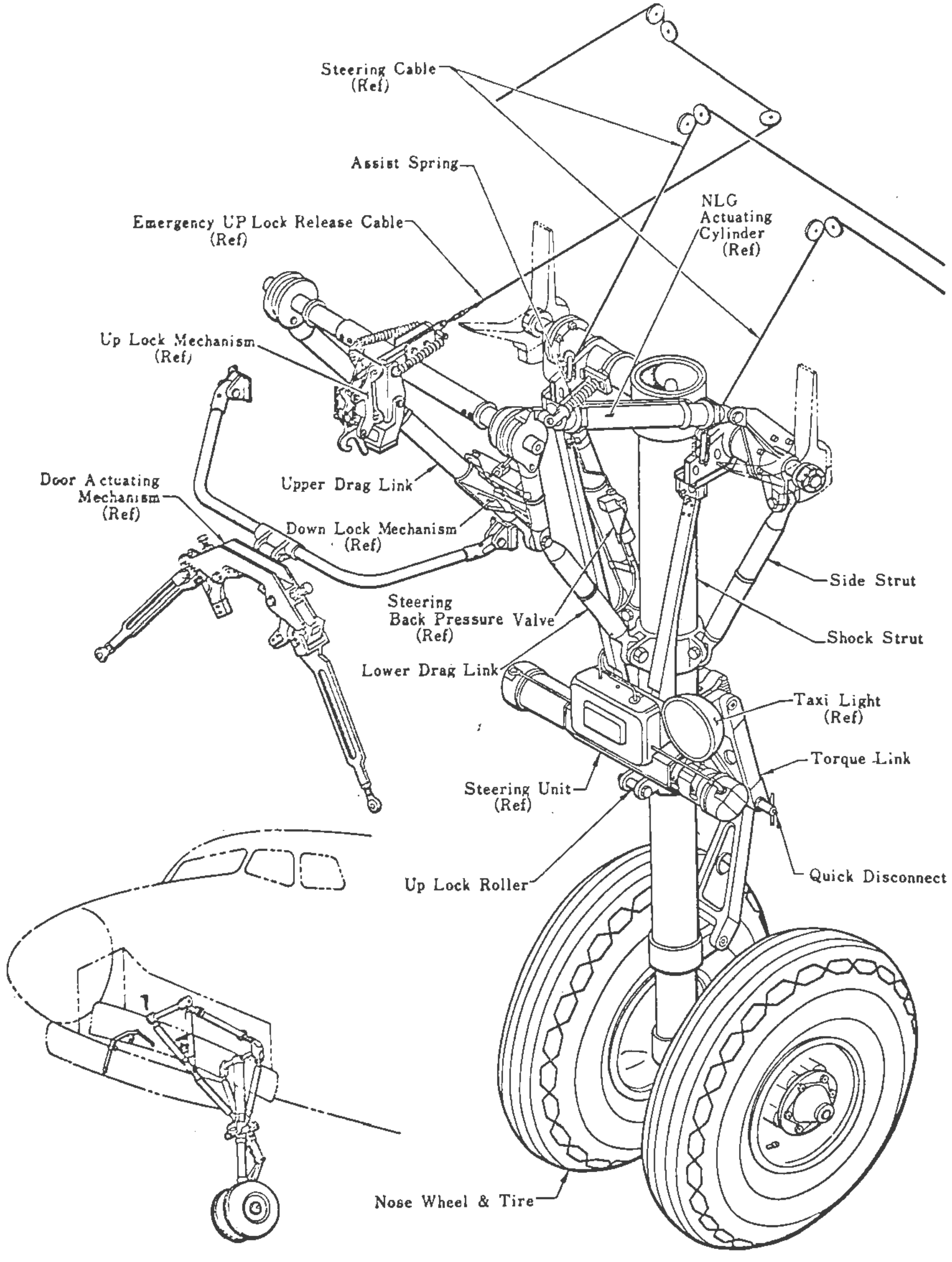
The drag link is composed of one lower drag link and two upper drag links.

The upper drag links are mounted on the fuselage at the forward portion of the landing gear well with pins and shaft; the lower drag link is fixed to the shock strut with standard bolts.

When the gear is extended, both links become a straight line and when retracted they are folded rearwards at the joint.

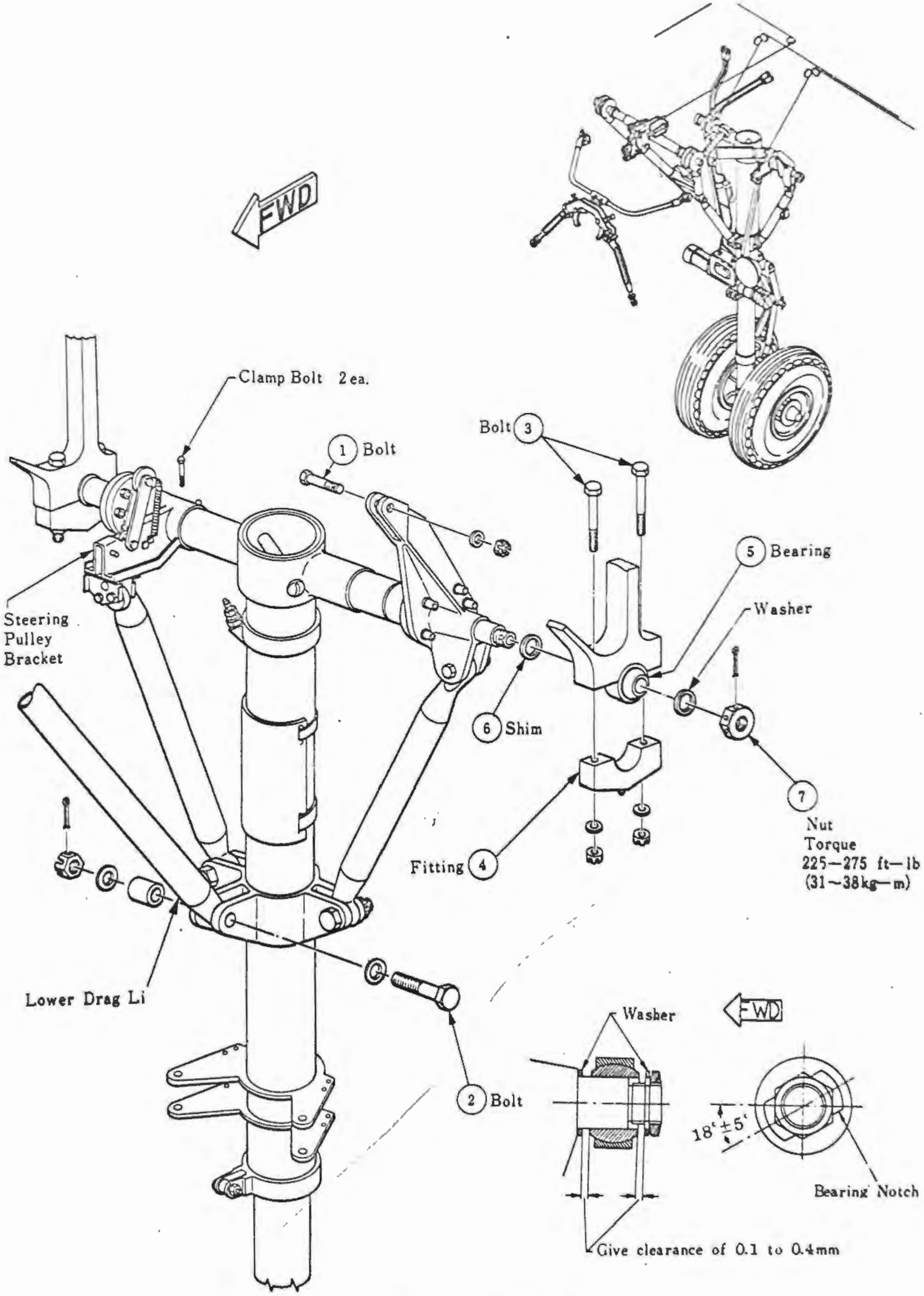
On the joint, there is a down-lock mechanism to lock the strut when the gear is extended.

On the pin of the upper mounting section of the upper drag link, a actuating cylinder and an assist spring are mounted.

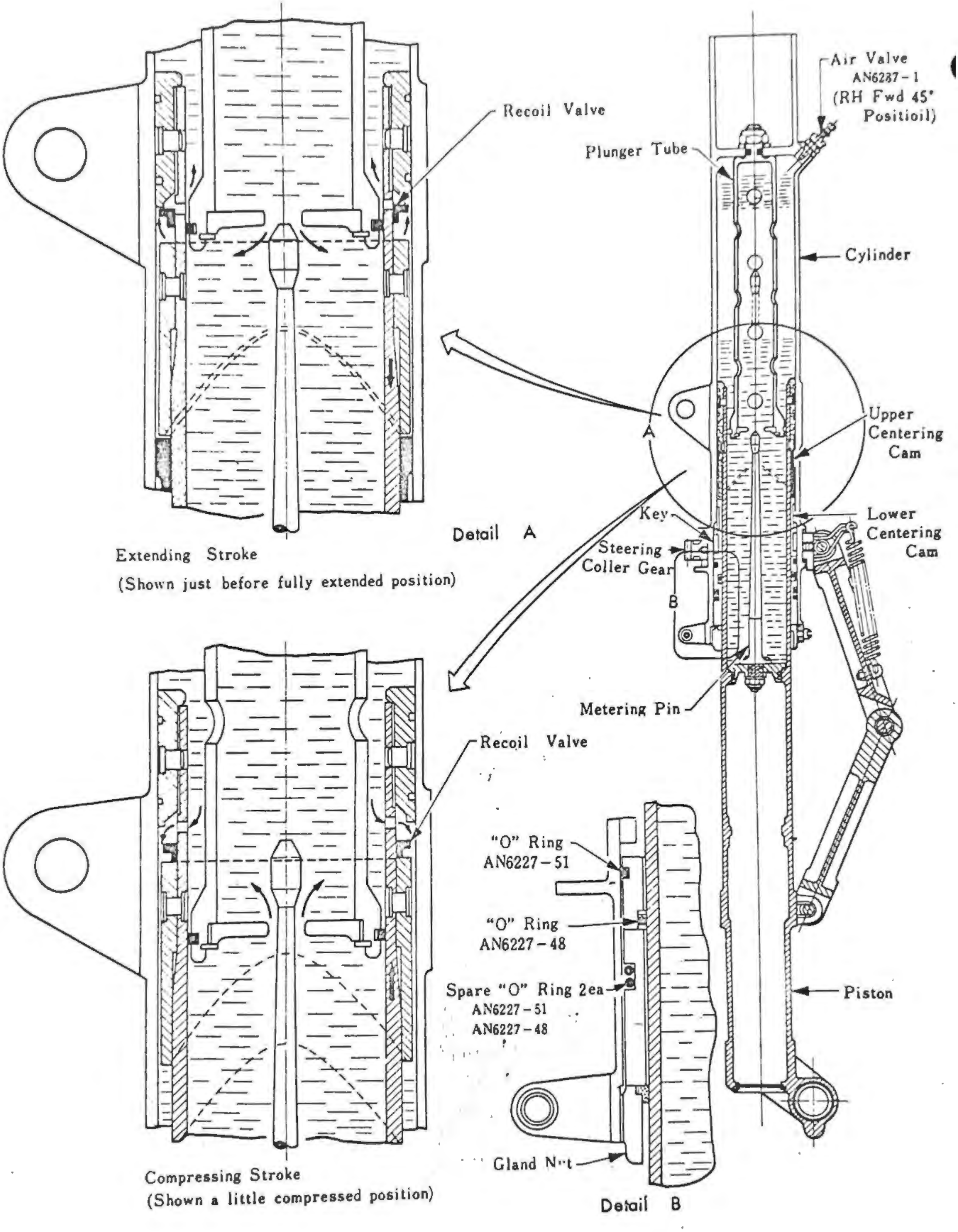


Nose Landing Gear

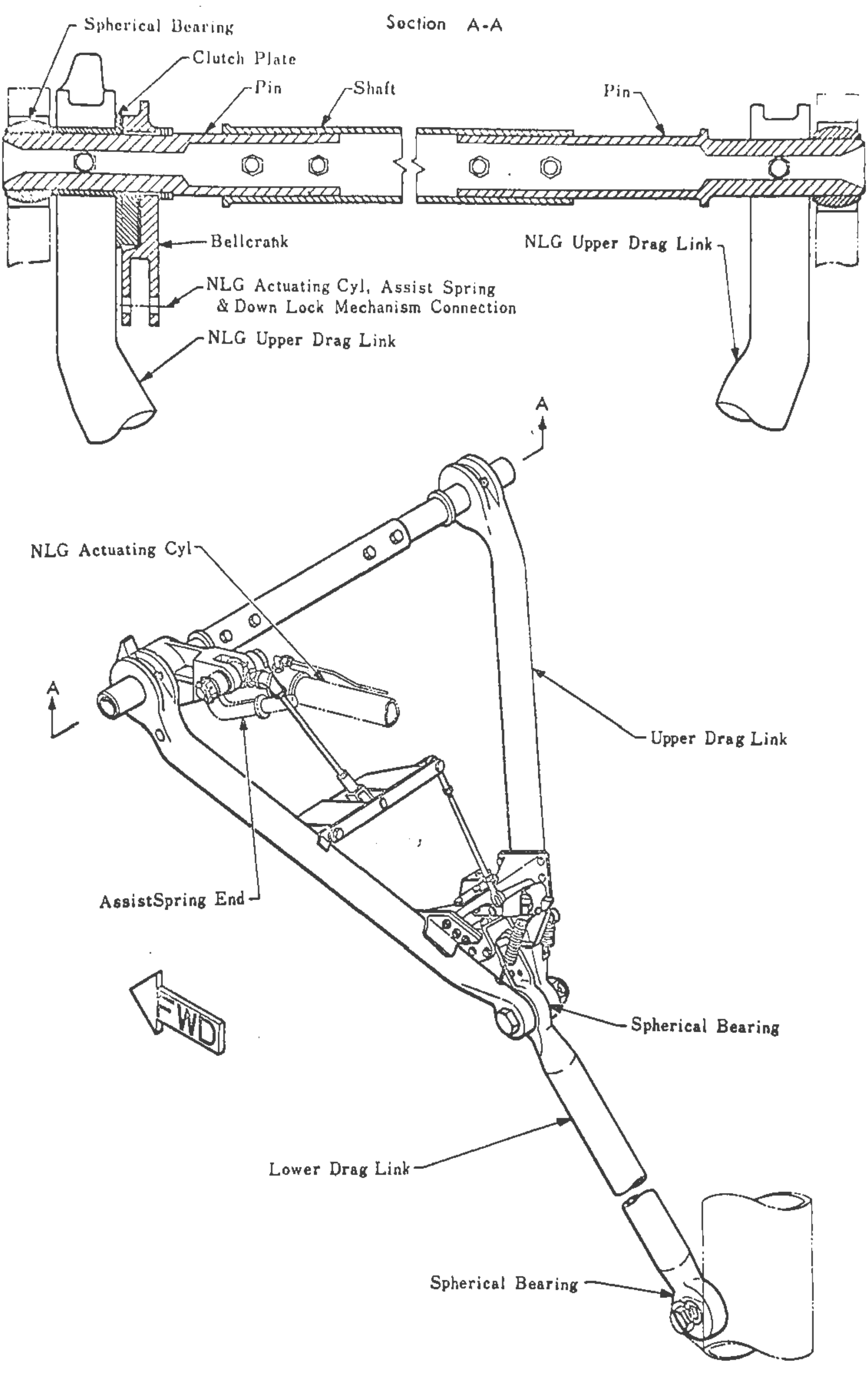
Figure 3-5



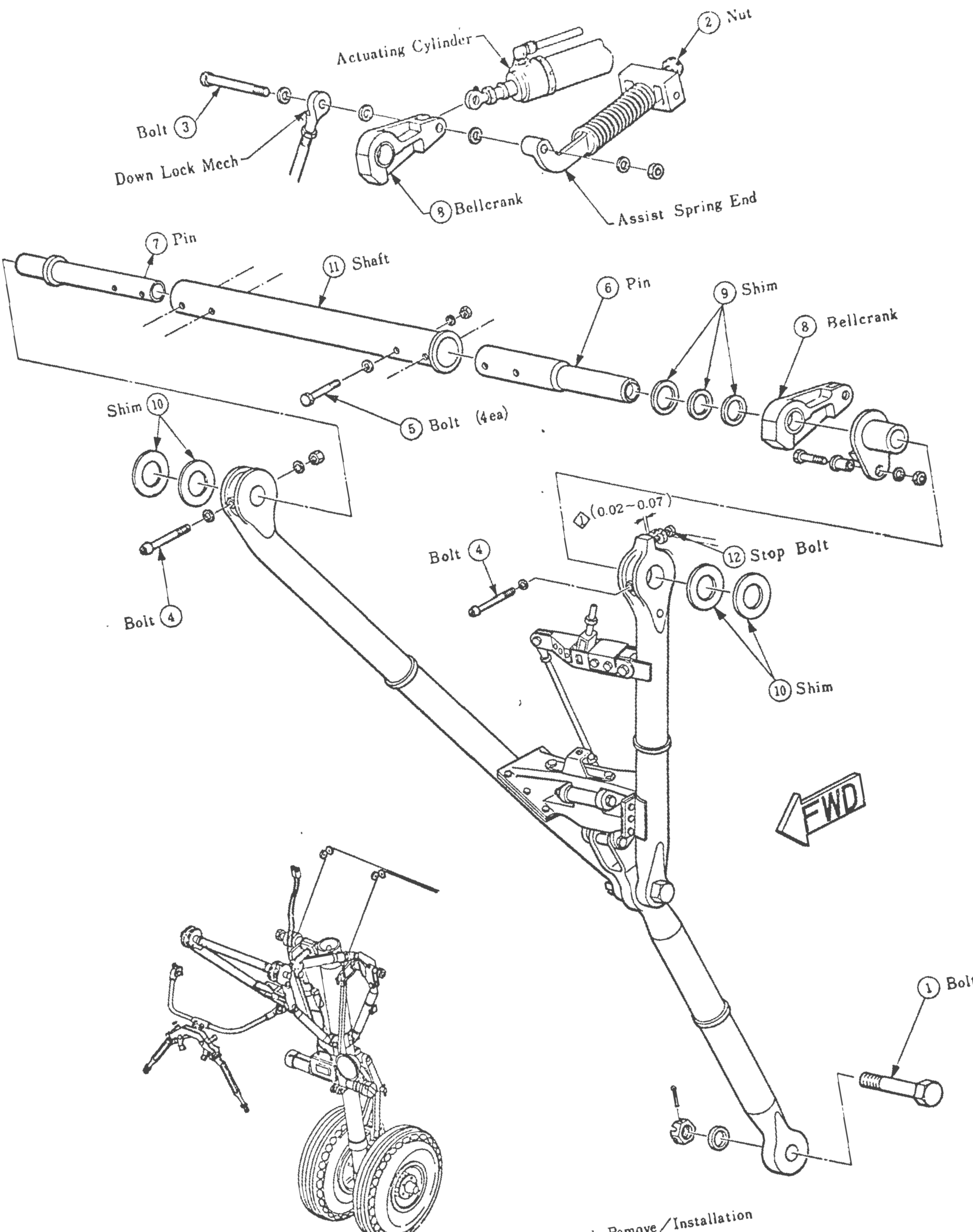
Nose Gear Shock Strut Remove/Install
Figure 3–6



Nose Landing Gear Shock Strut
Figure 3-7



Nose Landing Gear Drag Link
Figure 3–8



Nose Gear Drag Link Remove/Installation
Figure 3–9

3.4 Extension and Retraction System

3.4.1 Construction

The extension and retraction system consists of the following sub-systems:

(1) Landing Gear Selector Valve Control System

(2) Landing Gear Actuating Hydraulic System

(3) Down-Lock Mechanism

(4) Up-Lock Mechanism

(5) Main Gear Door Actuating Mechanism

(6) Nose Gear Door Actuating Mechanism

(7) Emergency Up-Lock Release System

3.4.2 Operation

(1) Retraction

A. When the landing gear lever is set to "UP" position, the cable connected to the lever operates the selector valve in hydraulic compartment, supplying pressure oil to each actuating cylinder and up-lock release cylinder.

B. The actuating cylinder releases the down lock, folds the drag link rearwards and retracts the gear.

C. When the gear is retracted, the door link is caught by the shock strut pulling up the door to close it.

D. Once the gear is retracted, the up-lock hook holds the up-lock roller attached to the shock strut and automatically the gear is locked in the up-lock position.

(2) Extension

A. When the landing gear is set to "DOWN" position, pressure oil is supplied to each actuating cylinder and up-lock release cylinder.

B. The up-lock release cylinder extends, releasing the up-lock.

C. The actuating cylinder extends the drag link to lower the gear.

D. The shock strut pulls the door downward to open it.

E. The gear is locked in the down-lock position.

(3) Emergency Gear Down

In case of hydraulic system failure, pull the emergency up-lock release handle installed on the front part of the right side-panel, and the up-locks of all the gears will be released permitting free falls

3.4.3 Operation Test

Jack up the aircraft, and connect the external power source and hydraulic test stand to the aircraft.

(1) Make certain the function of the indicating lights during retraction and extension, and also when the gear is locked in down-lock and up-lock position.

(2) Check the gear for its retracting operation, and the door for its closing operation.

(3) Set the gear lever to "NEUTRAL" with the gear up-locked.
Make certain that, when the engine throttle lever on one side is pulled back, the buzzer sounds and the light on the gear lever comes on. (When throttle lever is pulled back, the micro switch is energized.)

(4) Lower the wing flap to 22.5 degrees or more, and make certain that the buzzer sounds and the light on the gear lever comes on.

(5) Pull the emergency up-lock release handle, and make sure that the three gears can perform free fall.

(6) Set the gear lever to the "DOWN" position.

(7) Set the landing gear down-lock check switch to the "ON" position, and check the visual indicator.

(8) Ascertain that, when the circuit breaker of the scissor relay is drawn, the landing gear lever is not moved to the "UP" position.

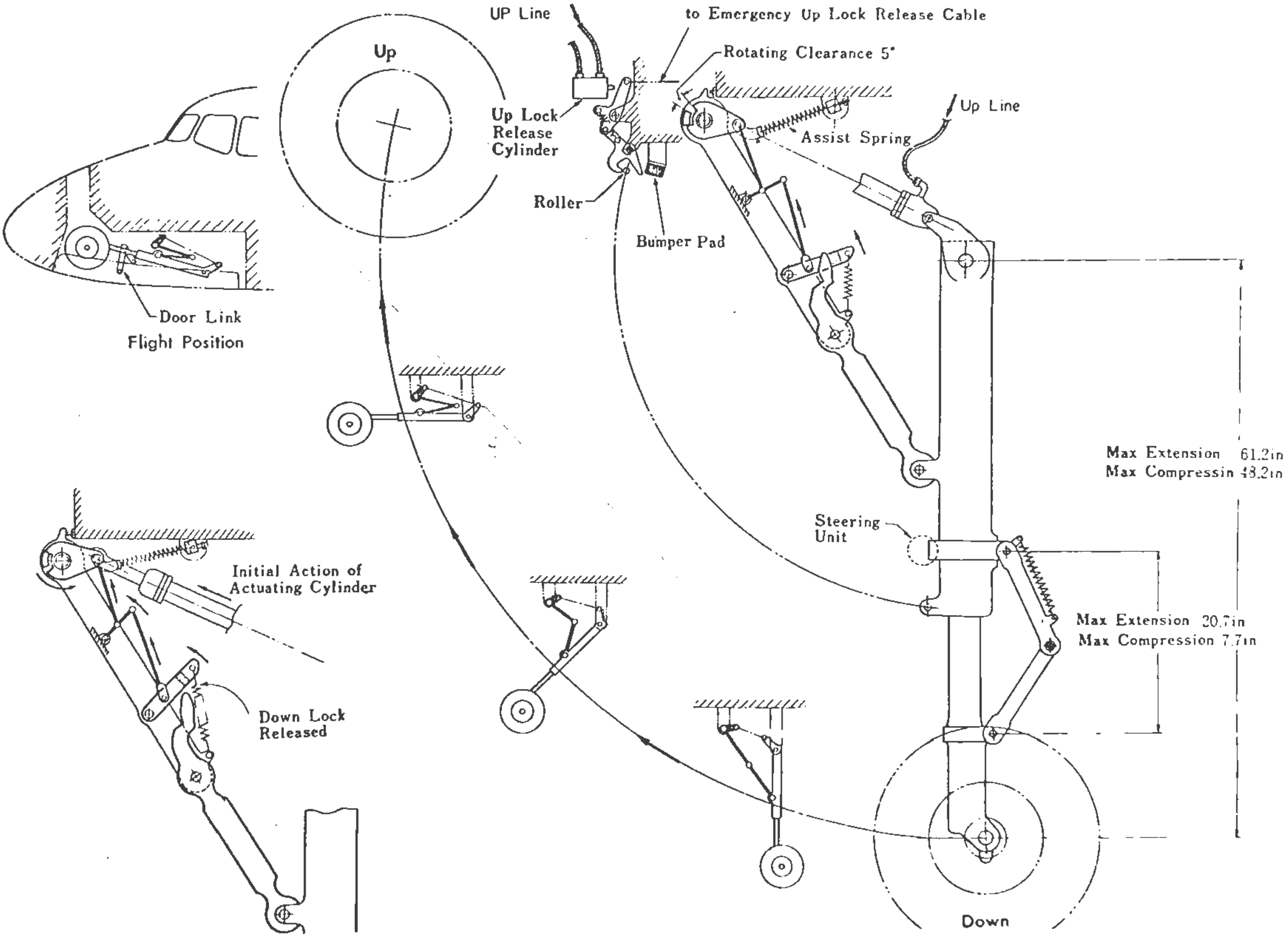
(9) With the override switch in "OVERRIDE", the gear is retracted.

(10) With the landing gear control lever set to the "UP" position, pull the emergency up-lock release handle, and make certain that, when the emergency landing gear release valve handle is pulled, the gear is allowed to make a free fall.

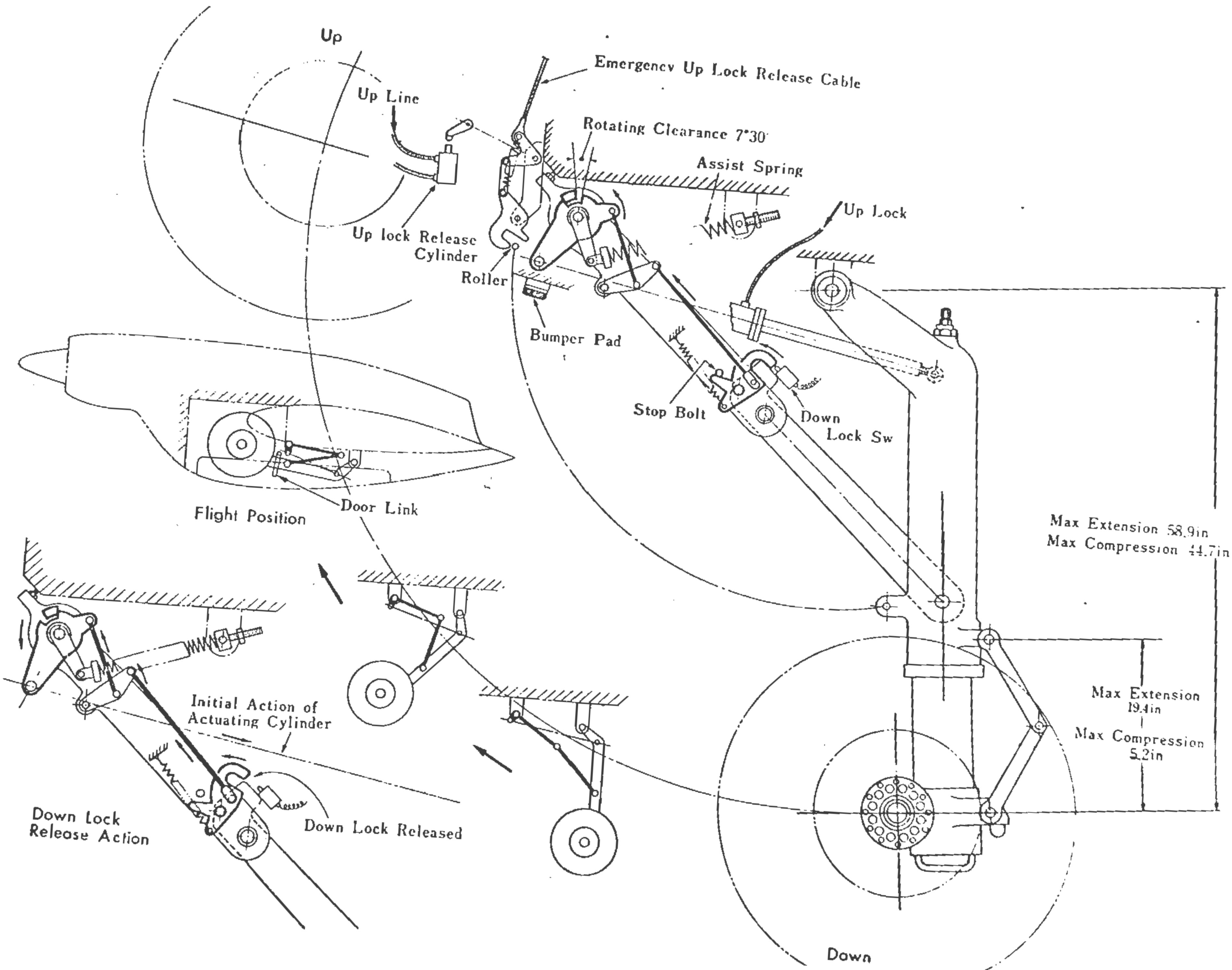
3.4.4 Landing Gear Selector Valve Control System

(1) General

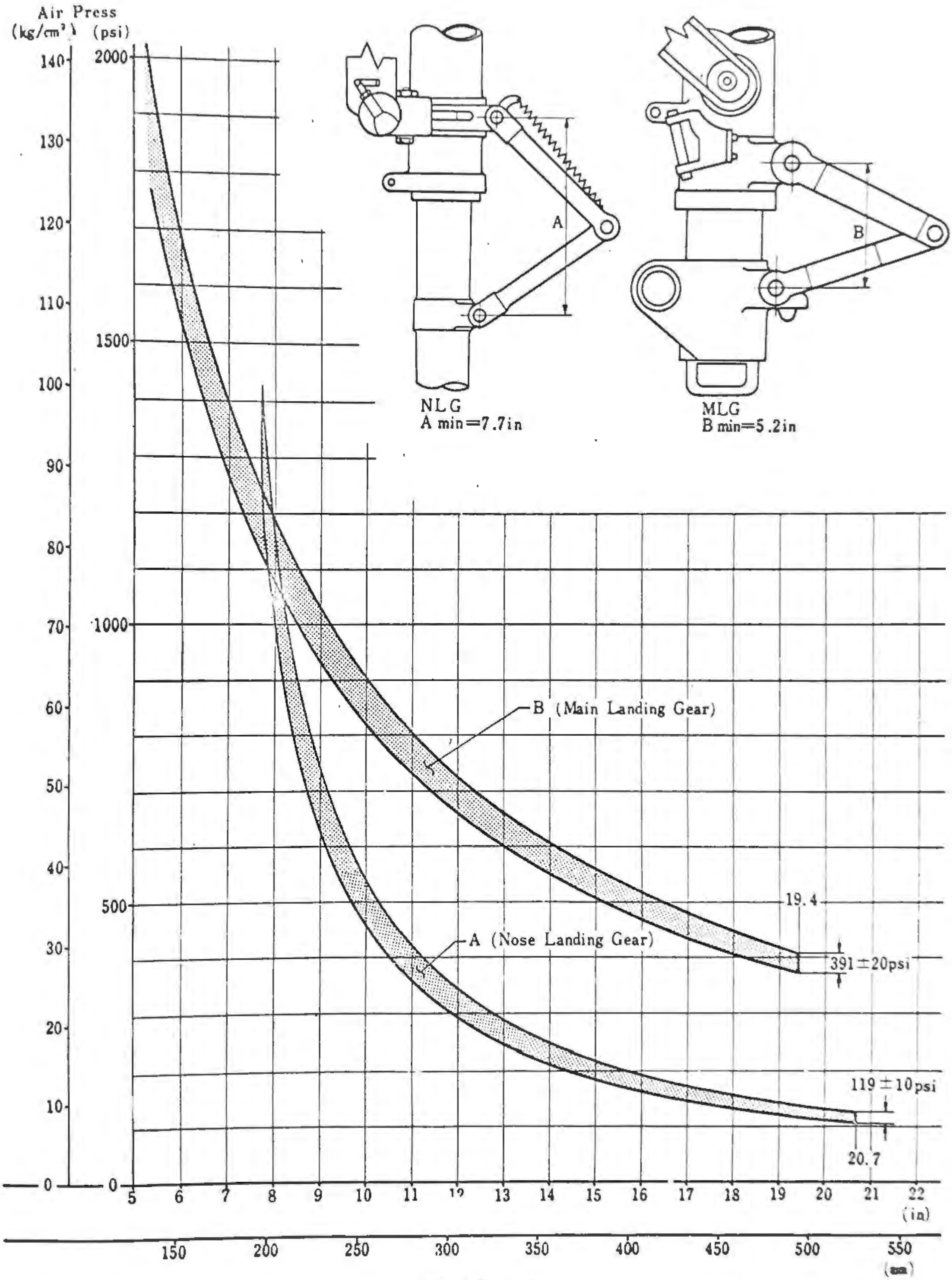
The landing gear control lever is located on the right-hand side of the engine instrument panel, and the motion of the lever is transmitted through the rod and cable to the landing gear selector valve in the hydraulic compartment.



Nose Gear Extension & Retraction
Figure 3-10



Main Gear Extension & Retraction
Figure 3-11



Landing Gear Shock Struct Air Servicing

Figure 3-11A

When the aircraft is on the ground a solenoid pin prevents the lever from moving to the "UP" position.
The solenoid pin is released when the aircraft becomes airborne (scissor relay is in "FLT"), then the lever can be moved to "UP". However, even the scissor relay has been set to "GROUND", the lever can be moved to "UP" if the override switch is turned to "ON".

WARNING: Do not turn the override switch to "ON" when the aircraft is on the ground.

(2) Adjustment

A. Install the rig pins (1), (2) and adjust the length of the rod (3).

B. Install the rig pin (5) and adjust cable tension.

The value of tension is 28.5 ± 4.4 lb at 20°C. (Cable tension varies by ±0.7 lb per 1°C.)

C. Set the selector lever to "NEUTRAL", and adjust the rod (7).

D. Move the gear lever up and down until the selector lever is switched to "UP" or "DOWN", and fix the adjust plate.

3.4.5 Landing Gear Actuating Hydraulic System

(1) Composition

This system is composed of the elements described below and hydraulic piping. The selector valve is located in the hydraulic compartment, and other elements are fixed on and around the landing gears.

A. Landing Gear Selector Valve

B. Main Gear Actuating Cylinder

C. Nose Gear Actuating Cylinder

D. Main Gear Up-lock Cylinder

E. Nose Gear Up-lock Cylinder

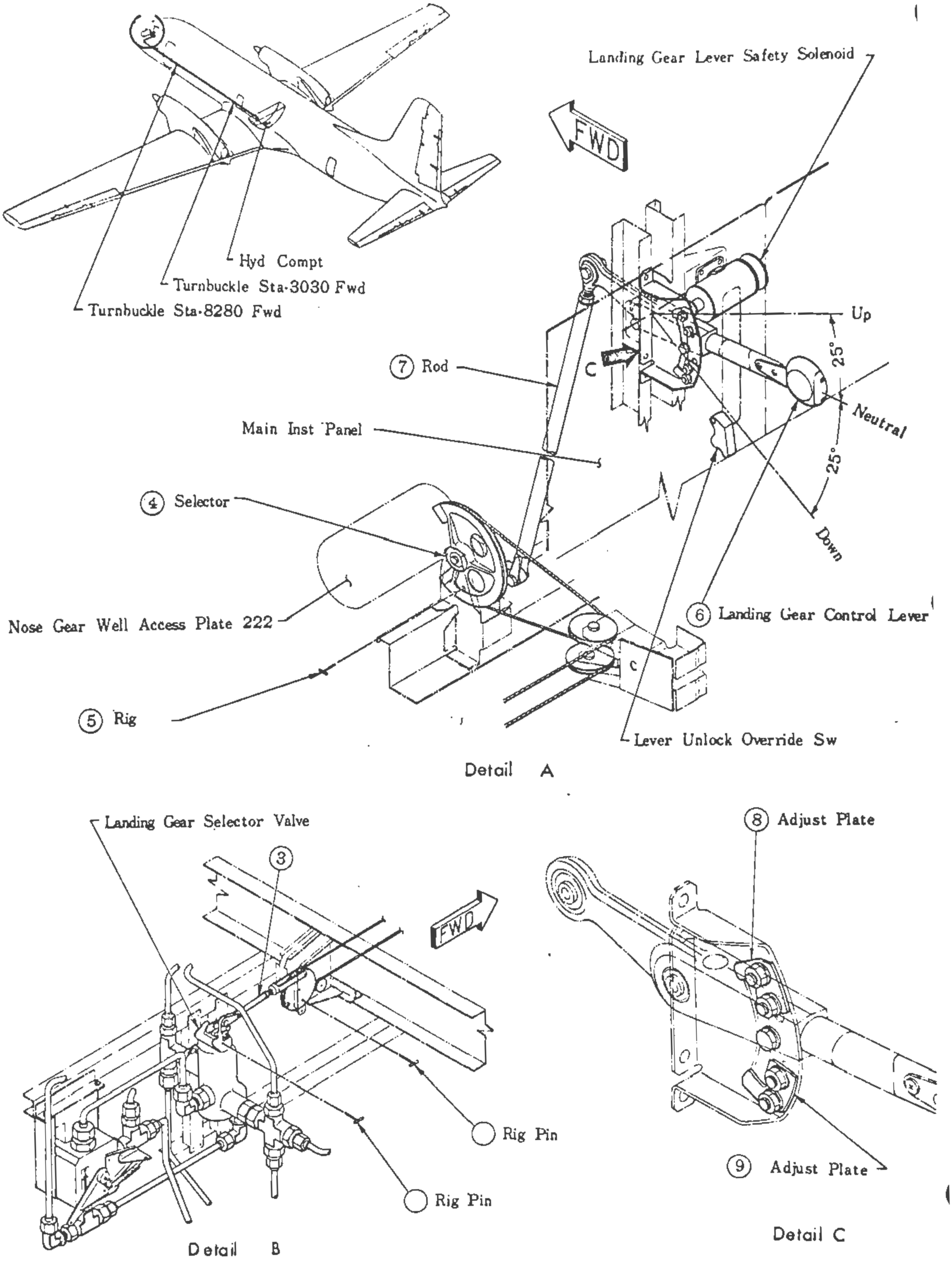
F. Main Gear By-pass Valve

G. Pressure Reducing Valve

(2) Operation

A. Gear Retraction

(A) With the landing gear control lever is "UP", the selector valve permits hydraulic pressure to enter the gear up line.



Detail A

Detail B

Detail C

Rigging-Landing Gear Selector Valve Control System

Figure 3-12

(B) The hydraulic pressure to the nose gear is reduced to 2000 psi through the pressure reducing valve.

(C) The up-lock release cylinder rod of the gears are retracted so that the gears can be locked mechanically by the up-lock hook.
The up-lock release cylinder is of simple reciprocating piston type.

(D) Pressure oil in the nose gear actuating cylinder extends the actuating cylinder. (releases the down-lock and retracts the gear)
The nose gear actuating cylinder is provided with dash pots at both ends which reduce impact load at the final stage of retraction; the stroke is 14.0 in.

(E) Hydraulic pressure in the "C" port under the by-pass valve of the main landing gear pushes upward the cone in the valve, reaching the "B" port, retracting the main gear actuating cylinder.
The main gear actuating cylinder is provided with dash pots at both ends; the stroke is 21.8 in.

(F) Hydraulic oil in the DOWN side of each actuating cylinder returns to the reservoir.

B. Gear Extension

(A) Set the landing gear control lever to "DOWN", and pressure oil from DOWN port of the selector valve flows into the DOWN line.

(B) All the up-lock release cylinders are extended, releasing them.

(C) The nose actuating cylinder is retracted (lowering the gear).

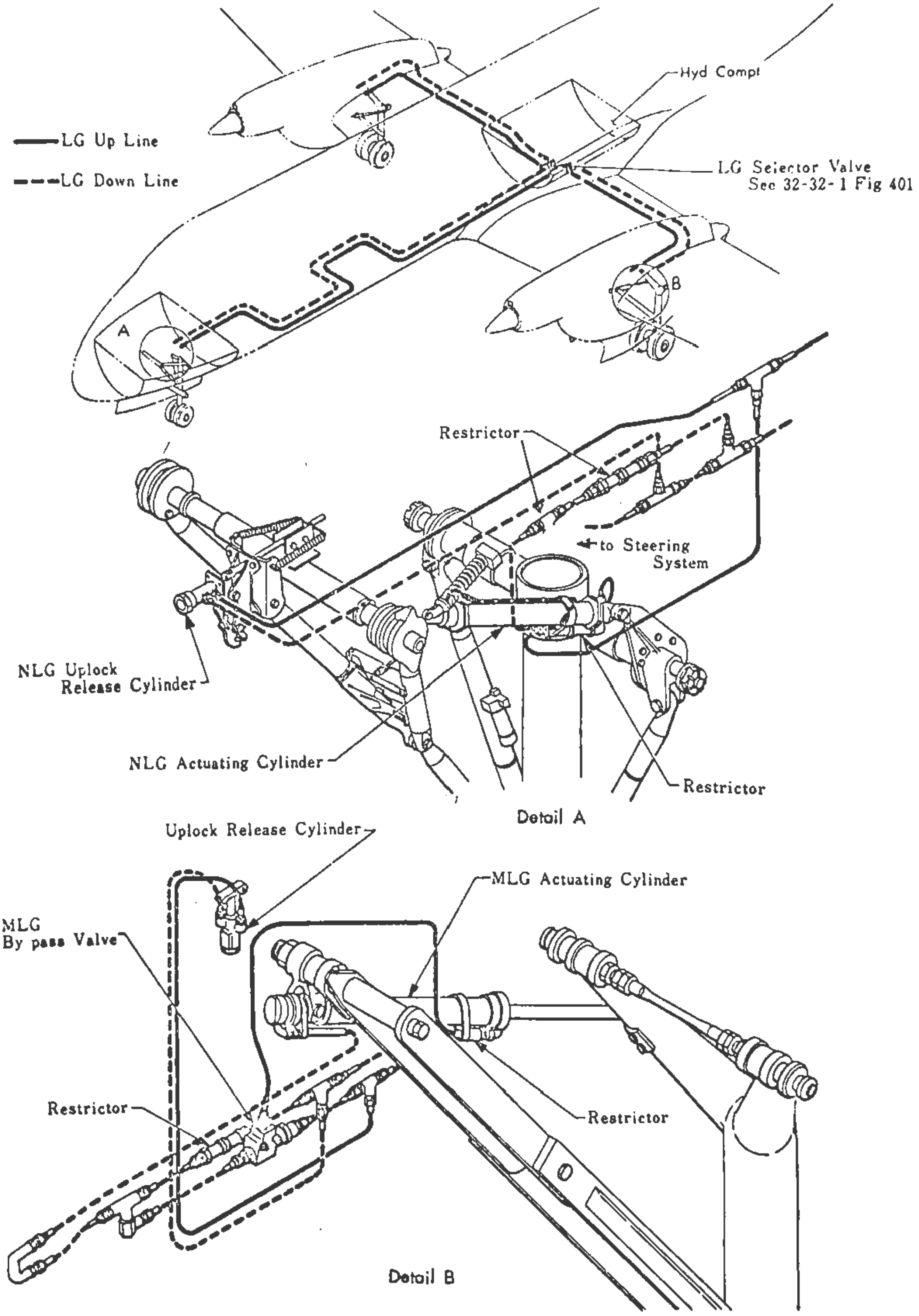
(D) In the case of main gear actuating cylinder, pressure oil enters both DOWN side and UP side, however, the piston can be extended to lower the gear due to the difference in area exposed to the oil pressure.

(E) Oil in the nose gear actuating cylinder returns to the reservoir through the UP line.

C. Emergency Landing Gear Extension (Free Fall)

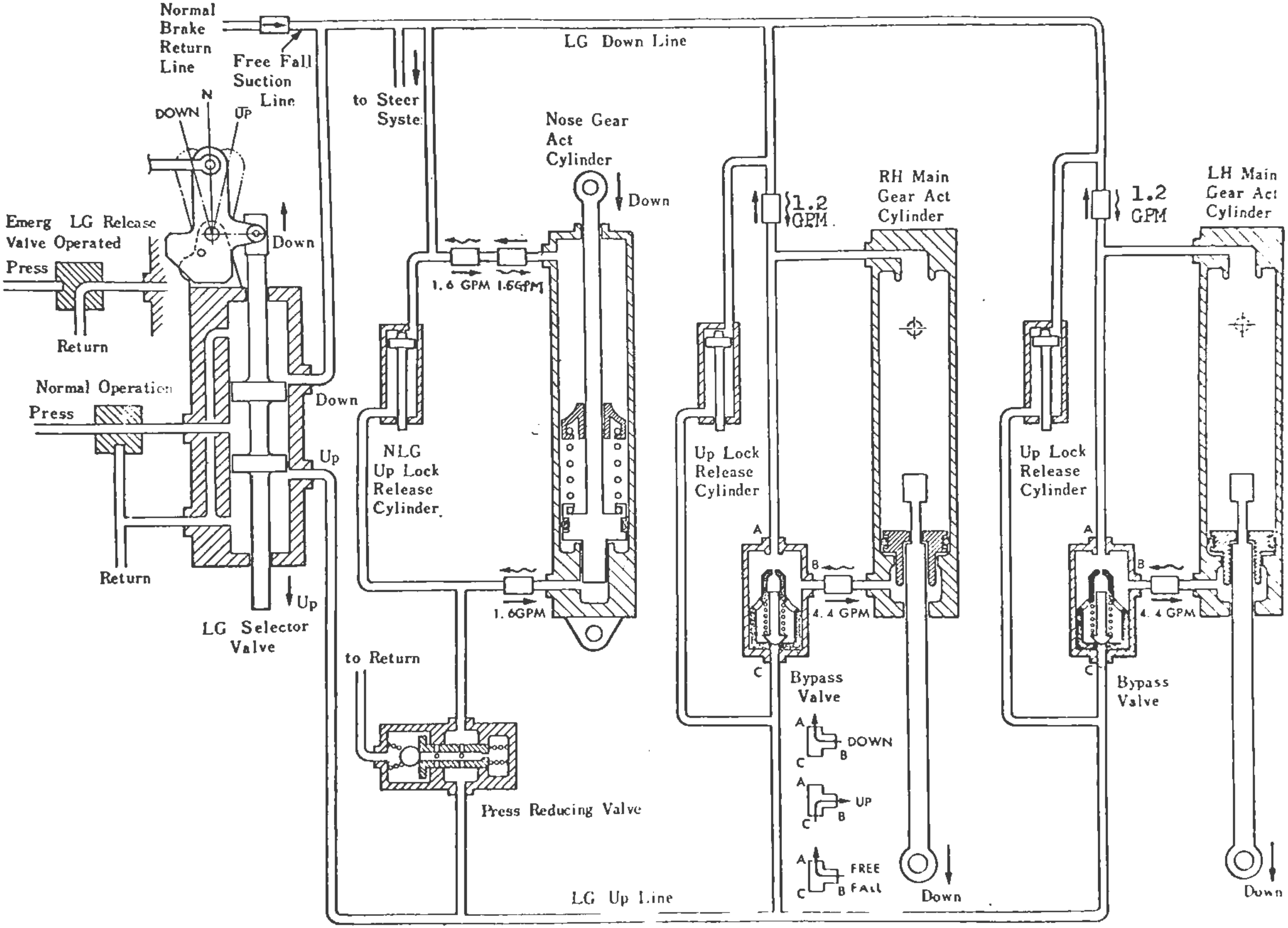
The landing gear can perform a free fall in the case of hydraulic system failure.

(A) Pull the emergency up-lock release handle, and all the up-locks of the gears are released through cables.



Landing Gear Actuating Hydraulic System

Figure 3–13



Landing Gear Actuating Hydraulic System
Figure 3-14

(B) The gears are lowered freely with their own weights.

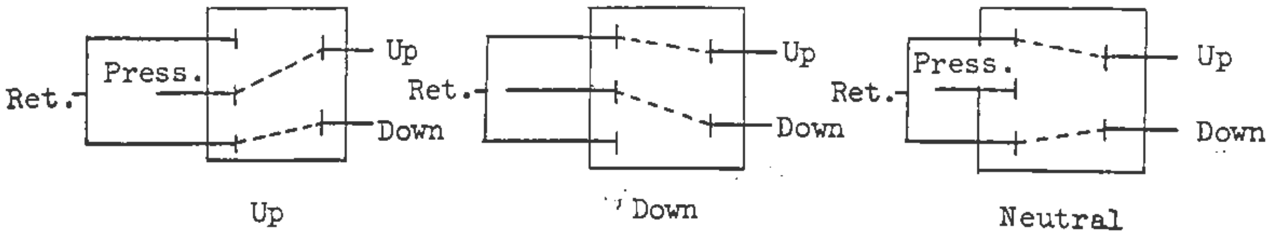
(C) Hydraulic oil in the nose gear returns to the reservoir through the UP line, while in the main gear, oil flows into the DOWN line through the by-pass valve.

(D) To fill up the shortage of oil in the DOWN line, oil or air is supplied from the brake return line.

(E) When the landing gear control lever is stuck at the UP position (the cable is cut), pull the knob of the emergency gear extension valve after pulling the emergency up-lock release handle, and the gear falls freely.

(3) Selector Valve

The selector valve is installed at the front, left corner of the hydraulic compartment. The valve is operated by a cable connected to the landing gear control lever. According to the lever positions, the following circuits are made:



(4) By-Pass Valve

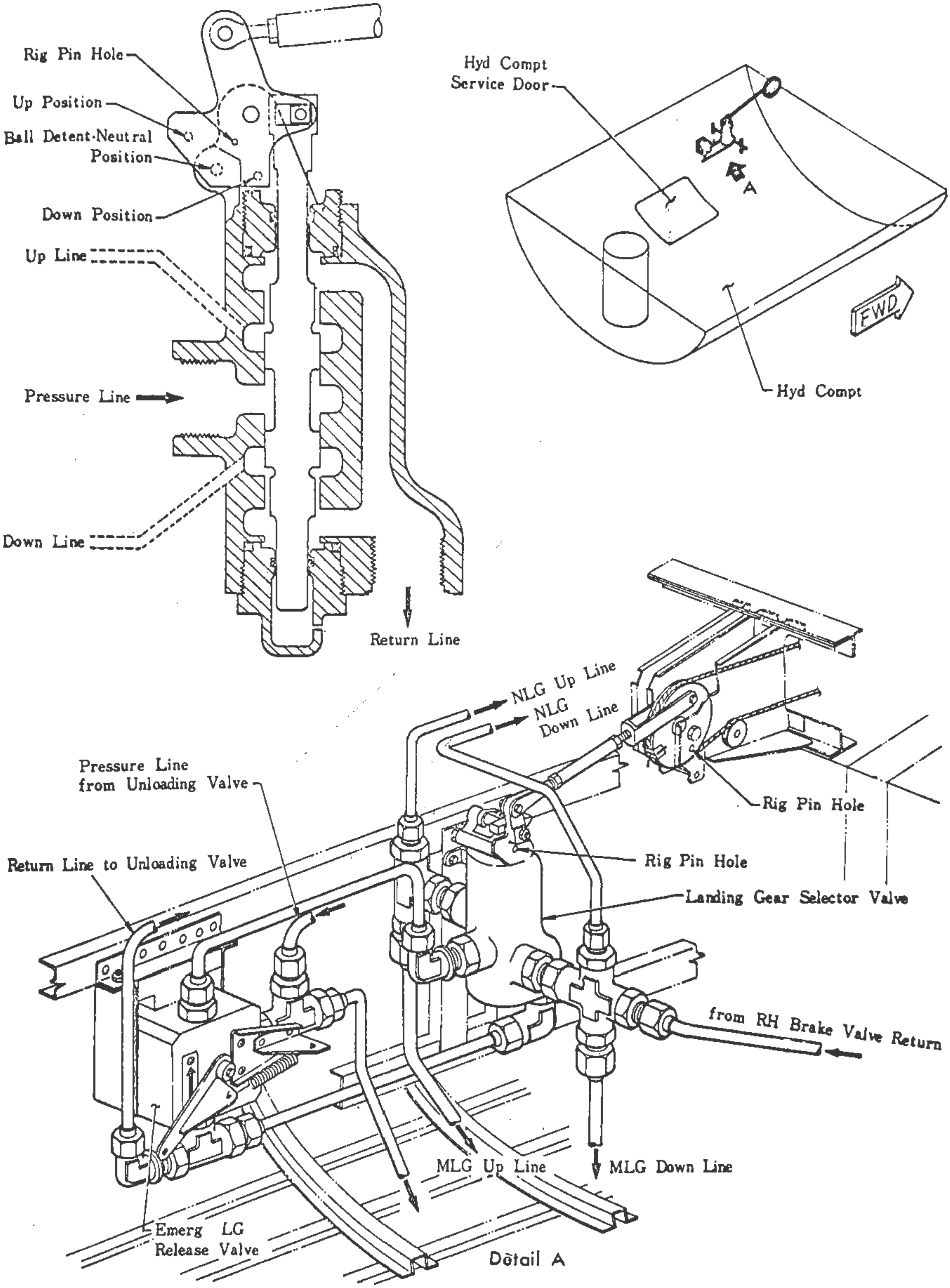
The by-pass valve is used for the following purposes:

A. Decrease the amount of pressure oil to be used for gear extension.

B. Reduce the piston area exposed to oil pressure at the time of gear extension to prevent buckling of the piston rod.

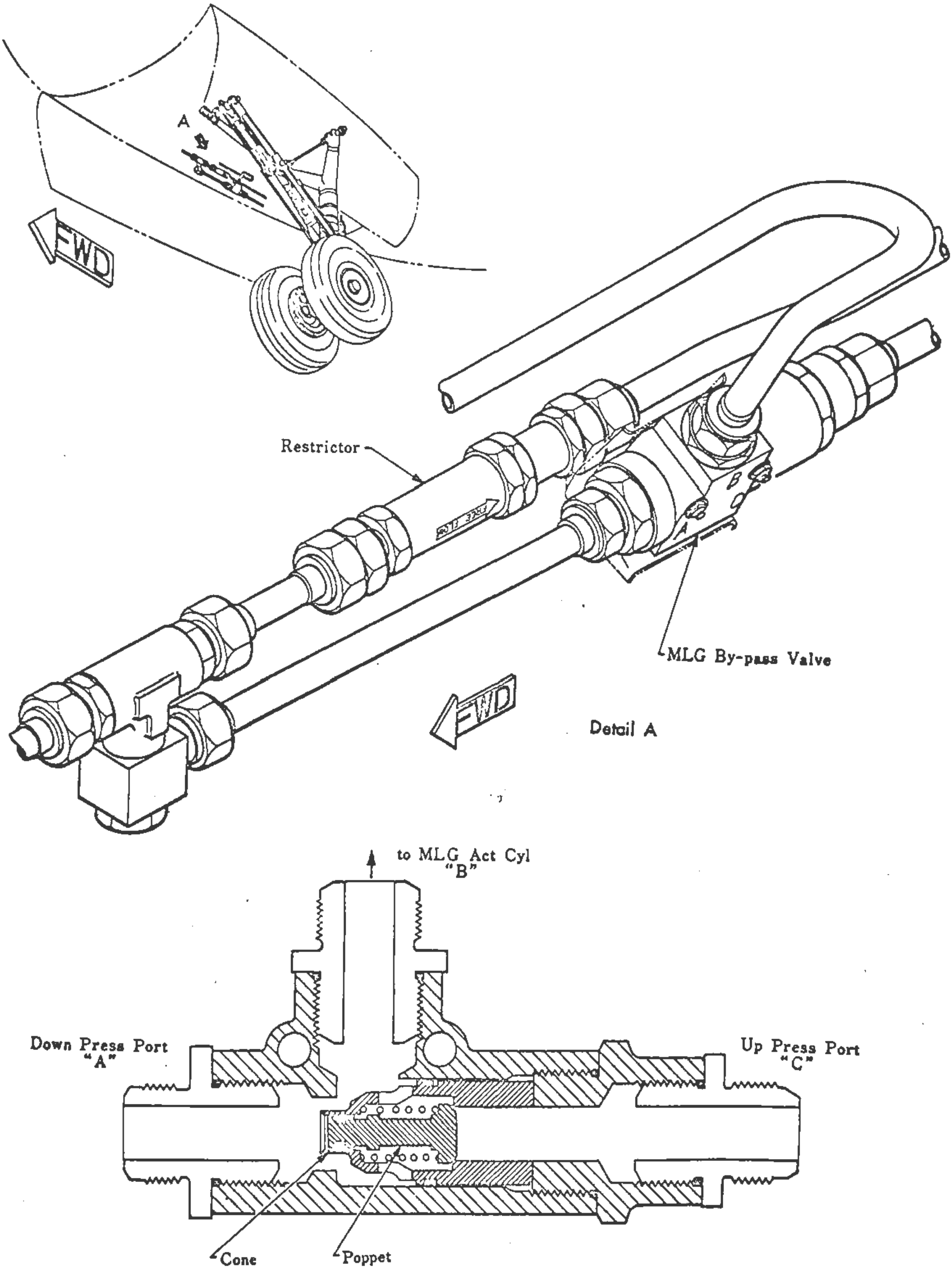
C. Shorten the hydraulic oil line used in case of emergency gear extension.

The by-pass valve is of shuttle valve type with a check valve and it has three ports; A, B and C. Their connection is shown below:



Landing Gear Selector Valve

Figure 3–15



Main Landing Gear By-Pass Valve

Figure 3–16

D,E. While lowering the gear, the bellcrank rotates at the beginning of operation of the actuating cylinder, and the aforementioned play (main 7°30', nose 5°) is transferred to the other side. The clutch plate, utilizing the rotating force, releases the drag link for gear extension.
As the lower drag link is extended, the hook comes in touch with the lower drag link which pushes the hook back. The hook, however, can not be pushed further because the hole in the rod end is slender.

F. When the drag link has been fully extended, the hook comes to the lock position by the spring.

(3) Assist Spring

The assist spring pushes the drag link in the direction of the drag link extension; in case of free fall, the assist spring assists the drag link to take a straight line securaly; on the ground, the assist spring prevents the drag link from being folded.

(4) Adjustment

A. Nose Gear Down Lock (Fig. 3-20)

(A) Adjustment before installation of the drag link.

Keeping the drag link in a straight line:

a. Adjust the clearance A using the shim (1).

b. Adjust the clearance B using the shim (2).

(B) Adjustment after the installation of the drag link.

Jack up the aircraft and relieve hydraulic pressure.

a. Pull the drag link forward by its center. When the A of both upper and lower drag links have come into contact with each other, adjust the clearance C by the stop bolt (4).

b. Adjust the rod (6) so that the lever (5) will be horizontal.

c. Adjust the clearance D by the rod (7).

d. Apply hydraulic pressure and make check Lock-Unlock operation of the down lock by operating the landing gear control lever.

B. Main Gear Down Lock

(A) Adjustment before installation of the drag link.

Keeping the drag link in a straight line.

a. Adjust the clearance A using the shim (1).

b. Adjust the adjust screw (2) so that it will come in contact with the plate (3).

(B) Adjustment after installation of the drag link.

Jack up the aircraft and relieve hydraulic pressure.

a. Pull the drag link forward by its center. When the adjust screw (2) has hit the plate (3), adjust the stop bolt (4) so that clearance B is within the specified limits.

b. Adjust the length of the rod (5) to 6.15 in.

c. Pull the drag link forward by its center, and adjust the rod (6) so that the clearance C is within the specified limits.

d. Apply hydraulic pressure, and check Lock-Unlock operation of the down-lock by operating the landing gear control lever.

3.4.7 Up Lock Mechanism

(1) General

Each gear is locked mechanically in its up-lock position and unlocked hydraulically. The construction and operation of the three gears are almost identical. The up-lock mechanism consists of the hook, link, lever and a couple of springs. The up-lock switch is operated by an arm attached to the lever.

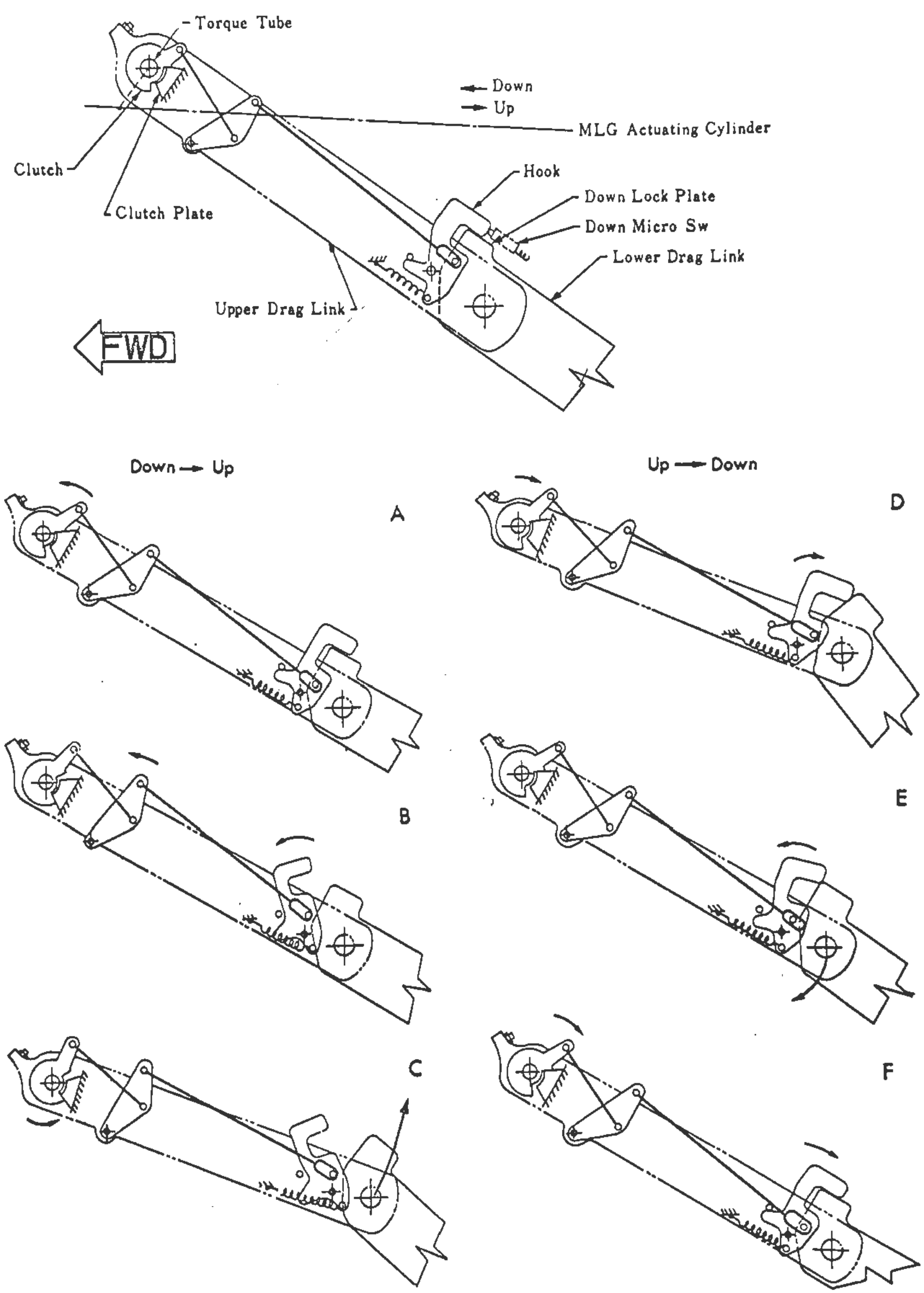
(2) Operation (Fig. 3-21, 3-22)

A. Gear Retraction

(A) The springs E and C hold the link mechanism ABCD in the alignment. The roller of the main gear shock strut comes up to push upward the hook at the upper jaw.

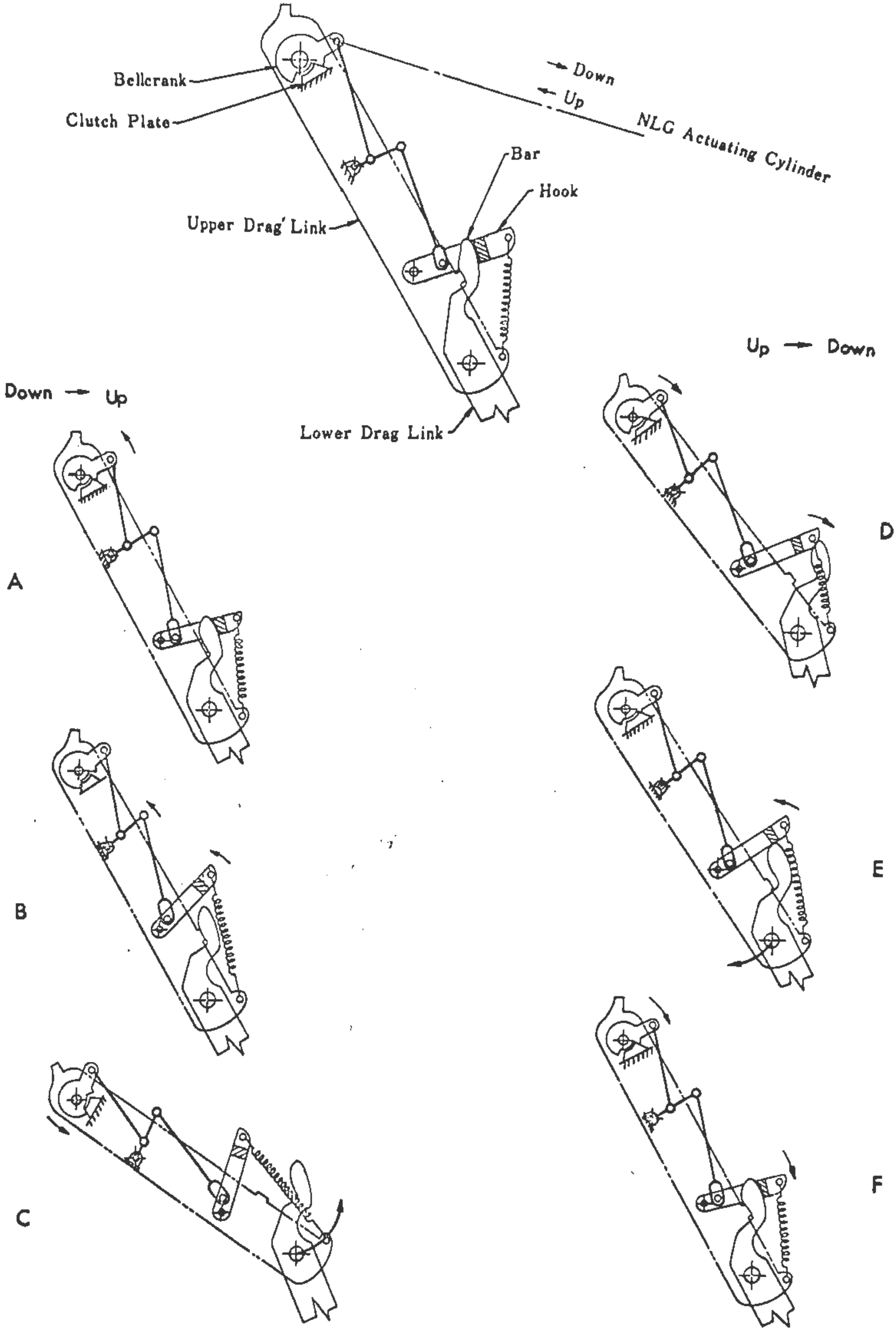
(B) When pushed upward, the hook rotates counterclockwise while extending the springs. So, the point C is pulled downward and the line connecting the points E, B and C becomes straight.

(C) As the hook rotates further, the point B is forced to the right of the line of the springs E and C; and accordingly the hook is suddenly rotated by the springs until it hits the stop bolt. As hydraulic pressure is relieved, the shock strut is lowered with its own weight, and the roller tends to rotate the hook. However, since the line of A B C is over-centered, the hook is not allowed to rotate.

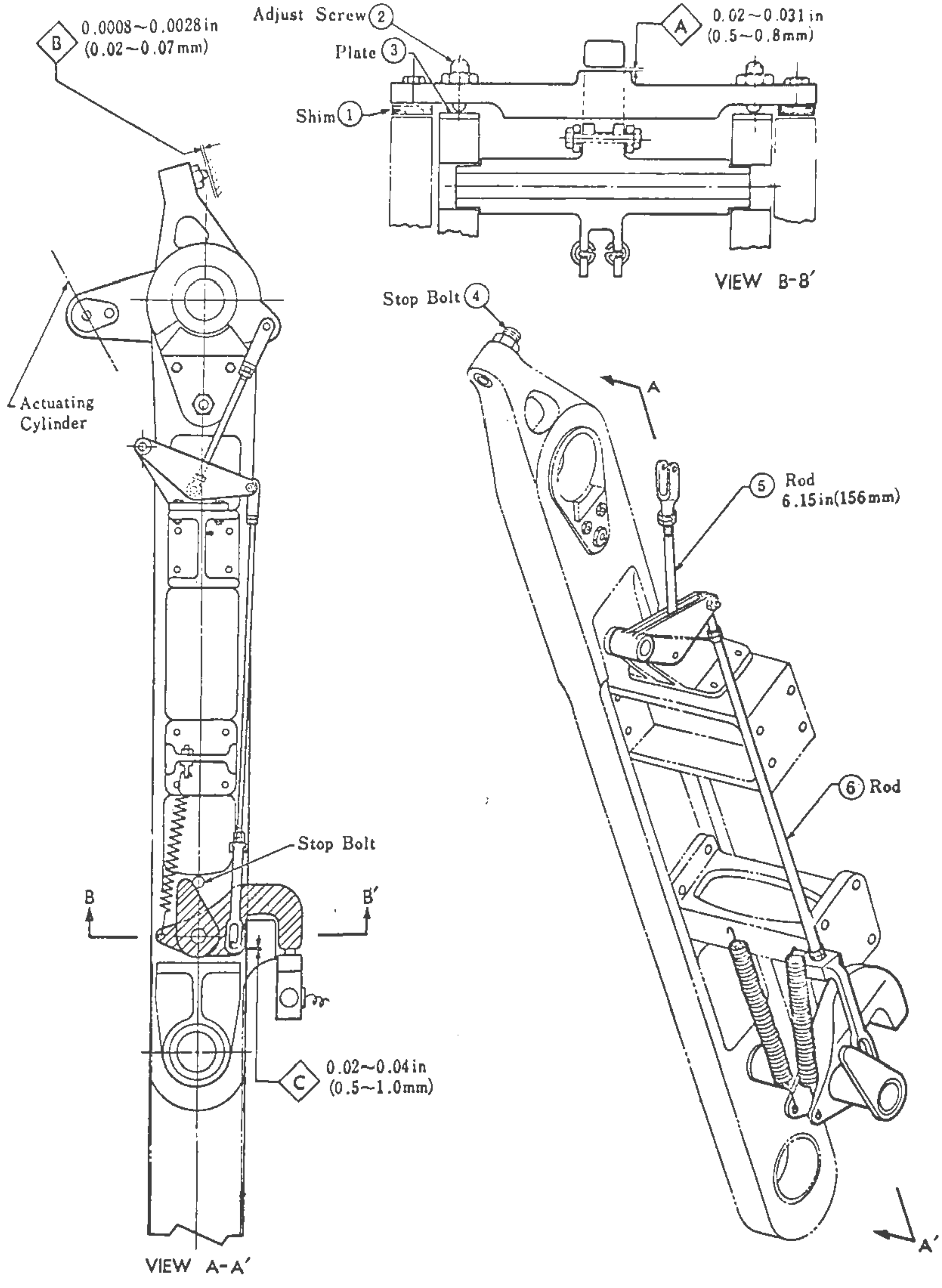


Main Landing Gear Downlock Mechanism

Figure 3–17

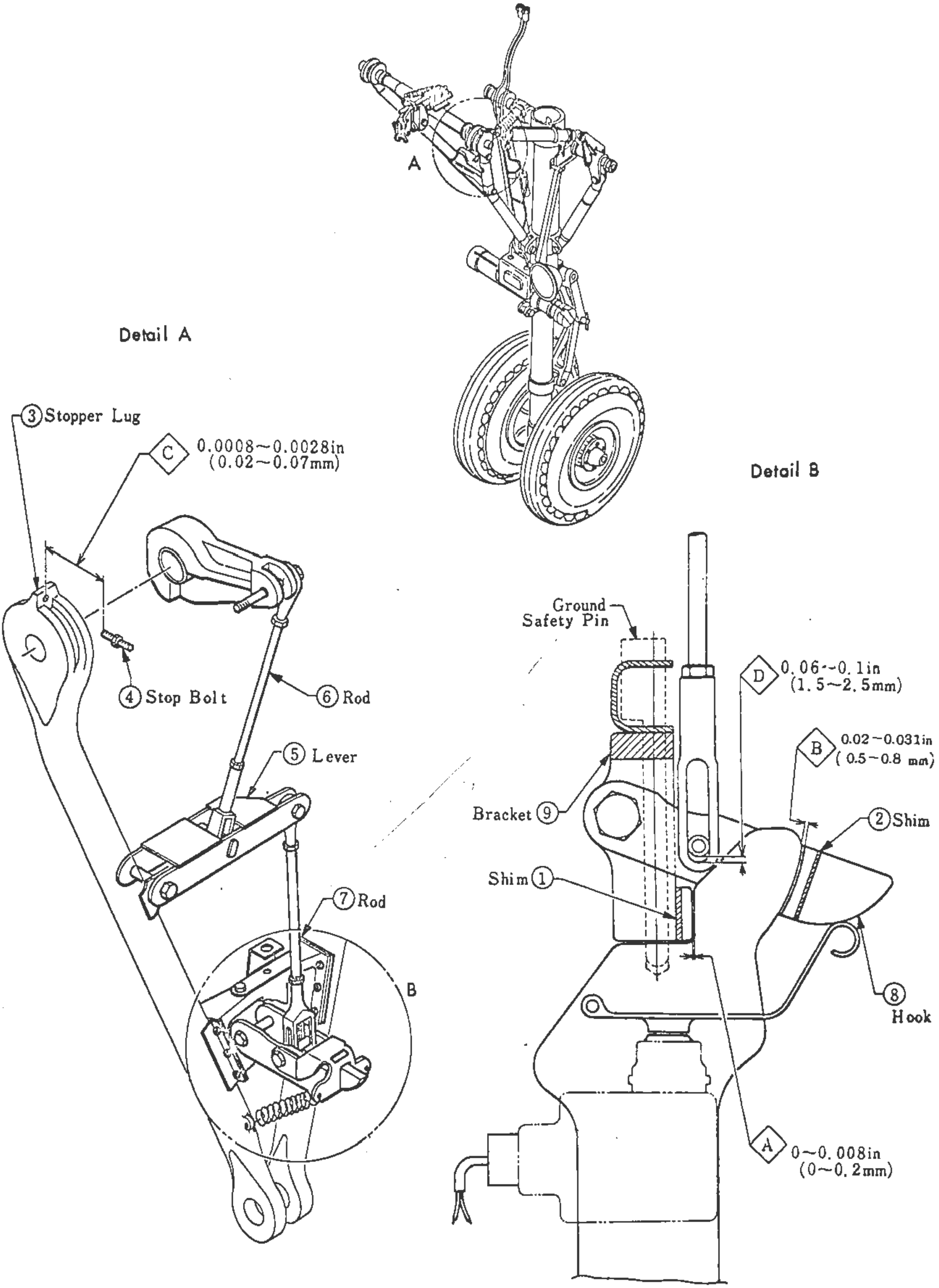


Nose Landing Gear Down Lock Mechanism
Figure 3–18



Adjustment-MLG Down Lock

Figure 3–19



NLG Down Lock Adjustment

Figure 3–20

(3) Adjustment

A. Nose Gear Up Lock (Fig. 3-23)

(A) Set the up-lock to the lock position, and adjust the stop bolt so that the clearance A is within the specified limits.

(B) Return the up-lock to the unlock position, and raise the gear. Make certain that the roller (6) does not come in contact with the top end of the hook.

(C) Check the clearance B and make certain the function of the bumper.

(D) Adjust the shim (7) so that the clearance C is within the specified limits.

B. Main Gear Up Lock (Fig. 3-24)

(A) Adjust the length of the link (1) to approximately 0.35 in.

(B) Set the up-lock to the lock position and adjust the stop bolt (2) so that the clearance B is within the specified limits.

(C) Unlock the up-lock and raise the gear. Adjust the shim (5) so that the clearance C is within the specified limits.

(D) Check the clearance E and make certain that, the function of the bumper.

3.4.8 Main Gear Door Actuating Mechanism

(1) General

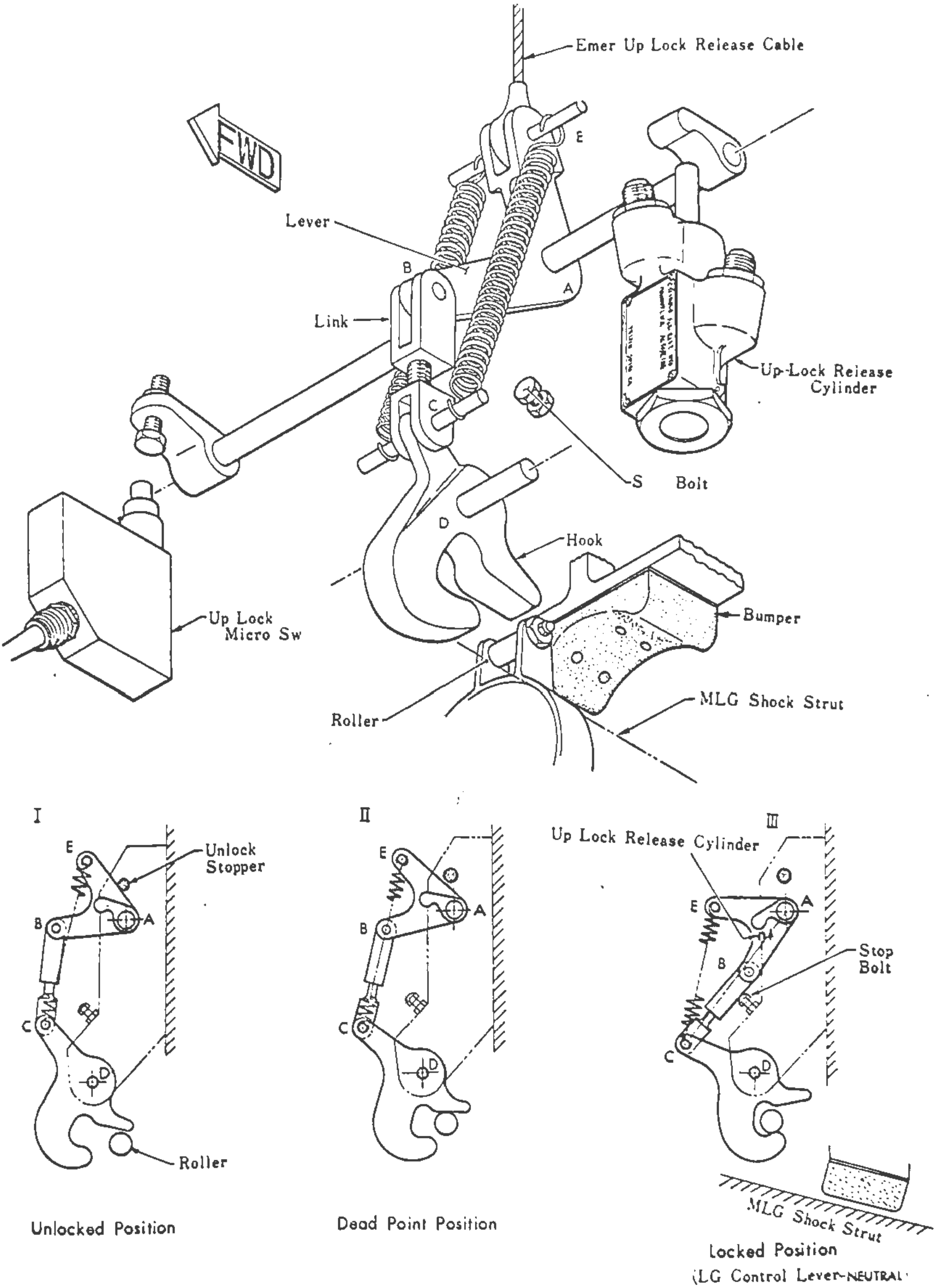
The main gear door is attached to the airframe with three hinges. The door is of double skin construction and the airplane can fly at airspeeds up to 245 kt (EAS) with the door open (landing gear down). The door actuating mechanism consists of the rod, bellcrank, arm, bar, guide and spring. The neutral position of this link mechanism is between the position II and III in Fig. 3-25, that is, the position of the saddle BC is about 2 in. higher than that of III.

The door will be locked open when the saddle BC comes down over the centerline of AD. (BC is overcentered)

(2) Operation (Fig. 3-25)

A. Gear Retraction

The roller attached to the main shock strut pushes the saddle upward and the door is closed in a sequence from IV to III, II and finally to I.

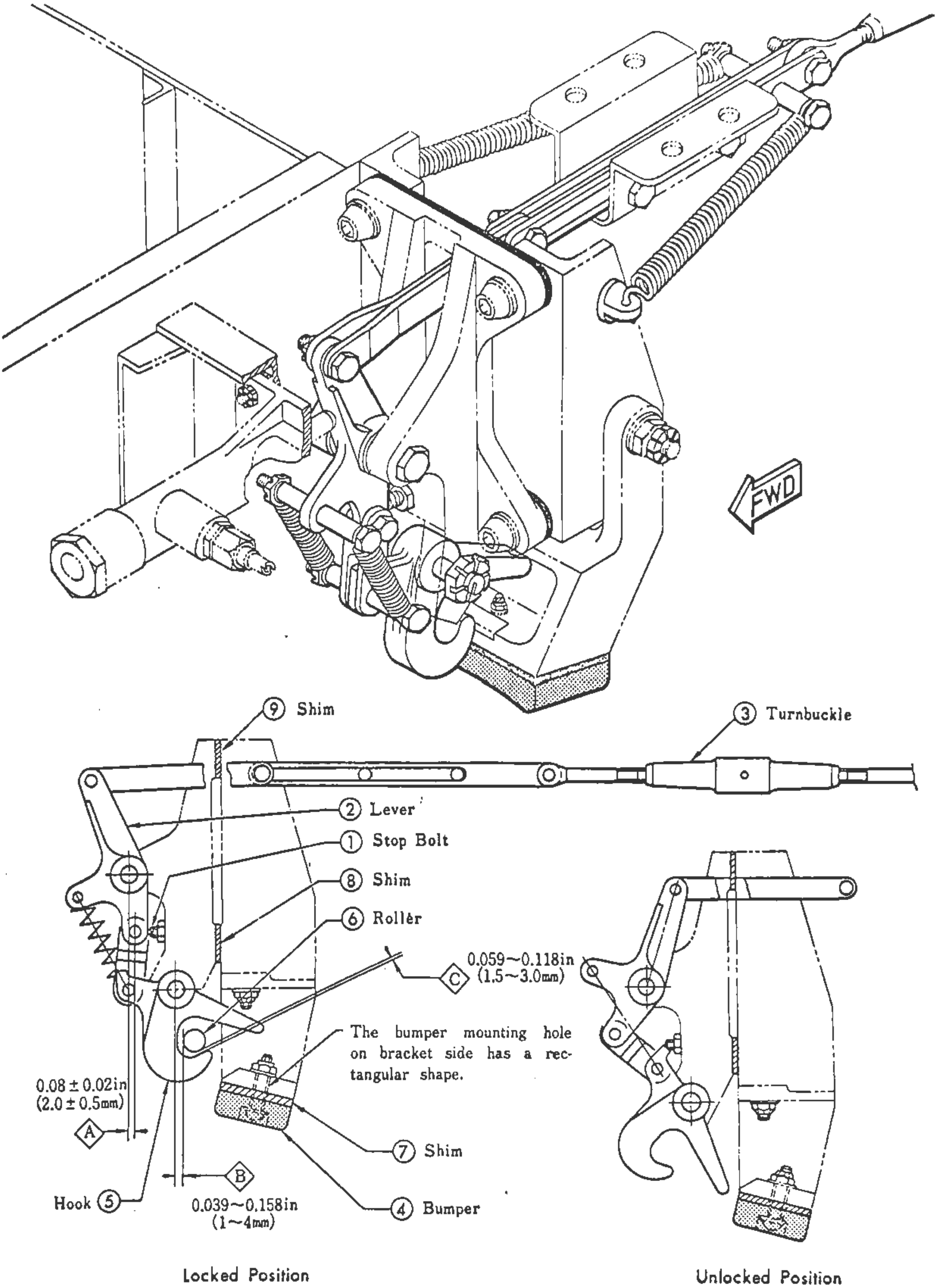


Unlocked Position

Dead Point Position

Locked Position
(LG Control Lever-NEUTRAL)

Main Landing Gear Uplock Mechanism
Figure 3-21



The bumper mounting hole on bracket side has a rectangular shape.

Locked Position

Unlocked Position

Nose Landing Gear Up-Lock and Bumper

Figure 3–23

The door does not have its own up-lock mechanism, however, the gear is locked in up-lock position locking the door indirectly in its up-lock position. (Closed position)

B. Gear Extension

As the main gear is extended, the roller goes into the hook to push it downward. Thus, the door is opened in a sequence from I to II, III, and finally to IV. At the position IV, the saddle is overcentered about 20 to 25mm and retained by the door spring.

(3) Adjustment (Fig. 3-26)

A. Detach the door spring and the adjust link (1) from the door linkage.

B. Adjust the lengths of the hook assembly (2) and arm assembly (3) and the stop bolt.

	Hook assembly and arm assembly	Stop bolt
Outboard	263 mm	23 mm
Inboard	232 mm	33 mm

C. When the landing gear is up and the door is at a standstill after overcentering, the clearance Ⓐ between the shock strut roller (8) and the guide (7) shall be 2.0mm at least and the hook (2) is set back from the guide (7) by 0.5 to 1.3mm. Adjust the serrations so that the difference of the clearances between the L.H. and R.H. (outboard and inboard) rollers and the guide is not more than 0.5mm.

Fine adjustment not more than 0.038in may be made by the stop bolt.

After the adjustment, make alignment marks on the serrations.

D. Reduce the clearances of the stop bolts to zero under the conditions described in para. C. While keeping the clearances zero, extend the bolts (both inboard and outboard) by 1/4 turn to preload them.

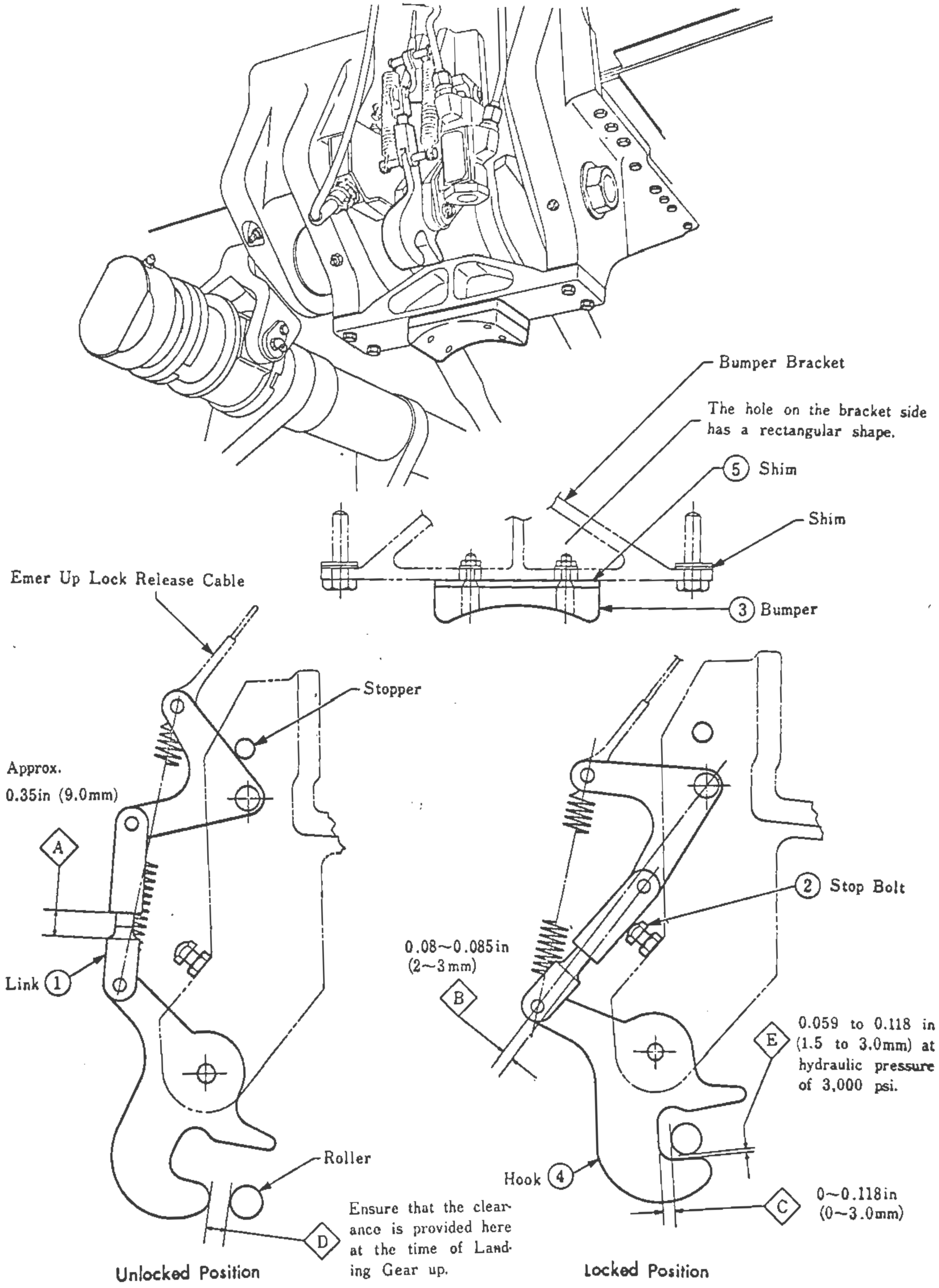
E. With the landing gear down, connect the door spring and the adjust link.

F. Adjust the adjust link so that the door and the nacelle contour are flush when the door is fully closed.

3.4.9 Nose Gear Door Actuating Mechanism

(1) General

The nose gear door is attached to the airframe with three hinges. The actuating mechanism consists of rod, saddle, lever, cam and brace; and the lower end of the mechanism, i.e., the rod end, is fixed to the door. The link mechanism is supported by the brace fixed to the wall of the gear well.



The hole on the bracket side has a rectangular shape.

Ensure that the clearance is provided here at the time of Landing Gear up.

Adjustment-MLG Up Lock
Figure 3–24

(2) Operation

A. Gear Retraction

D: The levers are held open by the springs securing the cam, so, the rod can not be folded.

C: The inner cylinder of the nose shock strut pushes up the lever, accordingly, the roller of the lever comes up to the end of the side arc of the cam.

B,A: As the shock strut is raised, the saddle pulls up the rods which, accordingly are turned inwards; and the clevis pushes up the cam, and the roller turns from the side arc to the end arc of the cam, and the door is fully closed.

B. Gear Extension

As the shock strut is lowered, the rods are turned outwards, accordingly the clevis functions to pull the cam to turn and the roller comes up to the end arc of the cam. The roller further moves to the side arc of the cam. When the door has been fully opened, there comes a slight clearance between the roller and the cam. Thus, the levers are opened to let the shock strut fall down freely from the door link.

(3) Adjustment

A. Adjustment before installation of the door linkage.

(A) Make the left and right levers (1) grasp the shock strut and adjust the shim (3) so that the levers and the stop assembly come in contact uniformly with the shock strut.

(B) Adjust the stop bolts (4) so that clearance ◇A is within the specified limits when the levers are fully opened.

B. Adjust the stop bolts (5) so that it may be in contact with the stopper with the doors fully opened but not in contact with the fuselage skin.

C. Install the door linkage.

D. Raise the landing gear slowly and make certain that the clearance ◇A is within the specified range; at the same time, adjust the shim (8) so that the clearances on both sides are equal.

E. Make certain that the rubber of both the stop assembly and the lever are in uniform contact with the shock strut.

F. With the gear up-locked and the control lever in the "NEUTRAL" position, adjust the rods (6) so that the doors can be closed tightly.

G. Lower the gear, adjust the clevis (12) and the stop bolts (5) to minimize the clearance ⟨B⟩.

H. Adjust the stop assembly so that the clearance between the side brace of the shock strut and the stop assembly (13) is 0.197 to 0.394 in (5 to 10 mm)

I. Operating the gear up and down, make certain that the clearance between the door and the steering cylinder is more than 0.276 in (7 mm) on both sides.

3.4.10. Emergency Up Lock Release System

(1) General

The emergency up-lock release system releases the up-locks manually in case of the hydraulic system failure.

The emergency up-lock release handle is located at the front part of the right console. A cable extending from this handle is branched off into three which are connected to the up-lock levers of the respective gears. The pulling force transmitted to the lever from the handle is eight times the force needed to pull the handle. The cable installation is so designed as to provide some slackness or play necessary for the normal operation of the gear.

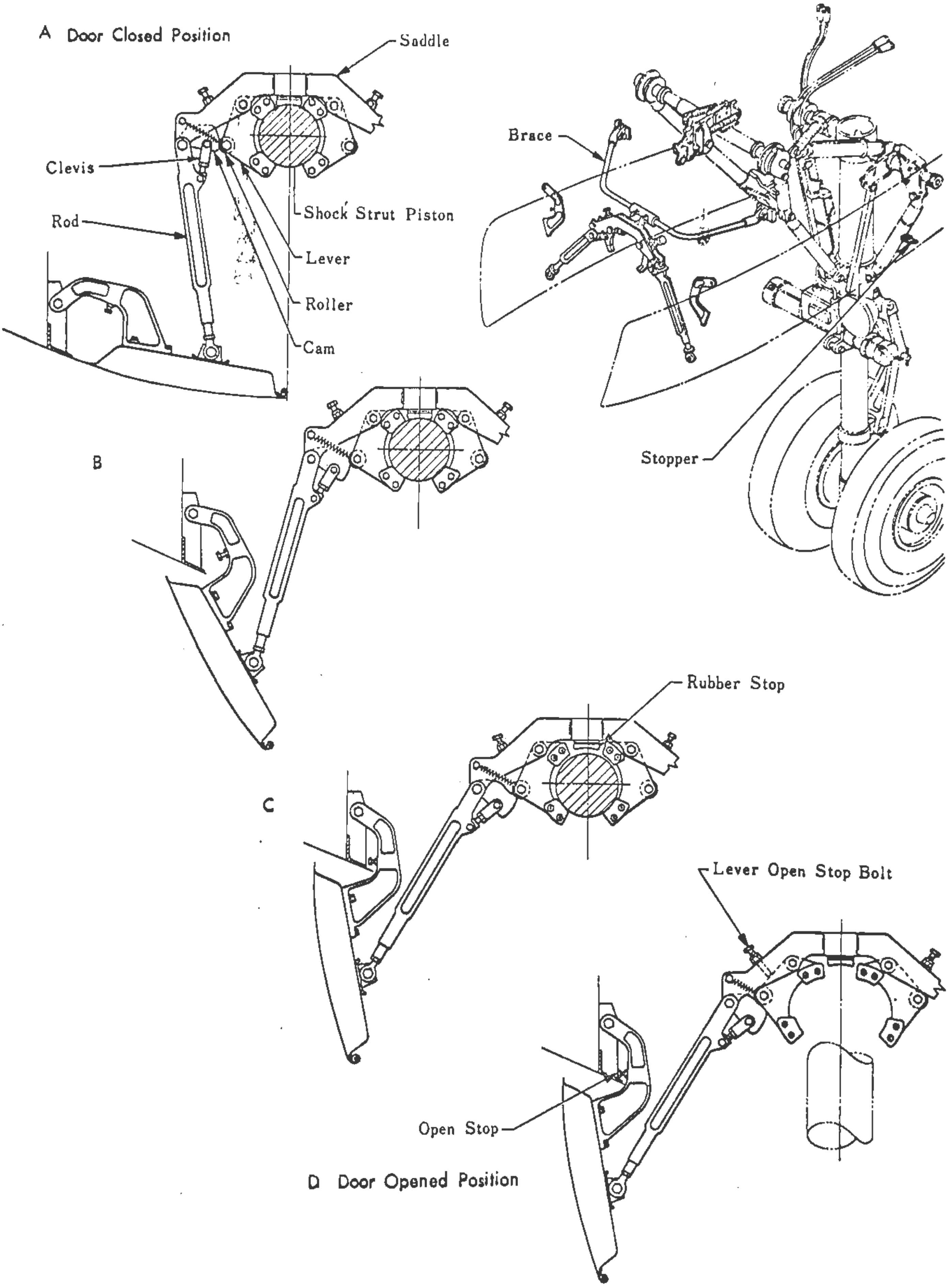
(2) Adjustment (Fig. 3-30)

A. Take off the floor plate CIR in the cockpit and insert the rig pin (2) into the sector (1).

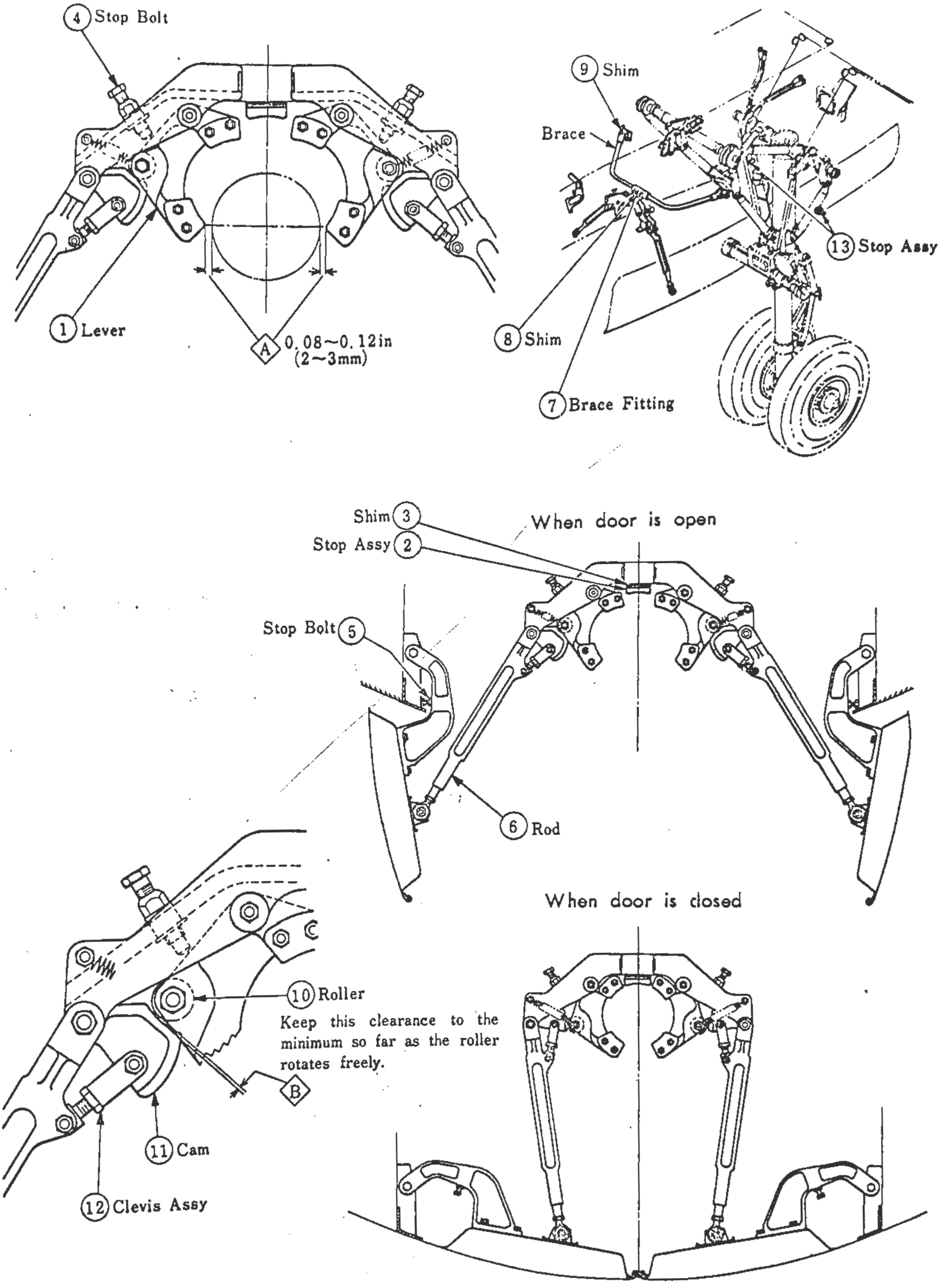
B. Adjust the turnbuckle (3), (4) and (5), so that the clearance at ⟨A⟩ and slackness at ⟨B⟩ are in existence.

C. Adjust the turnbuckle (7) to such an extent that the rig pin (2) can be pulled out easily.

D. Pull out the rig pin (2) and pull the handle (6) fully to make certain that all up-locks are unlocked.

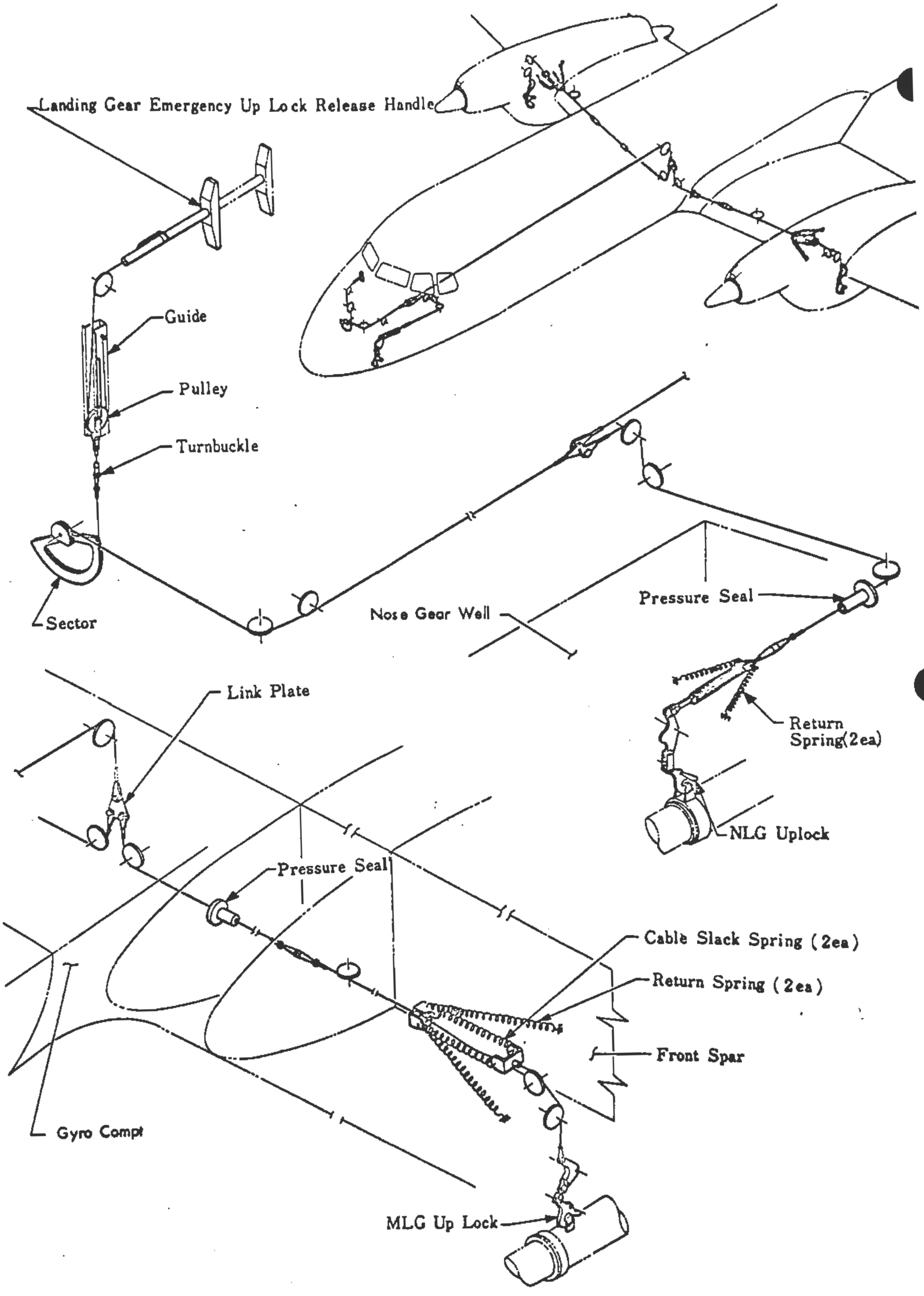


Nose Landing Gear Door Actuating Mechanism
Figure 3–27

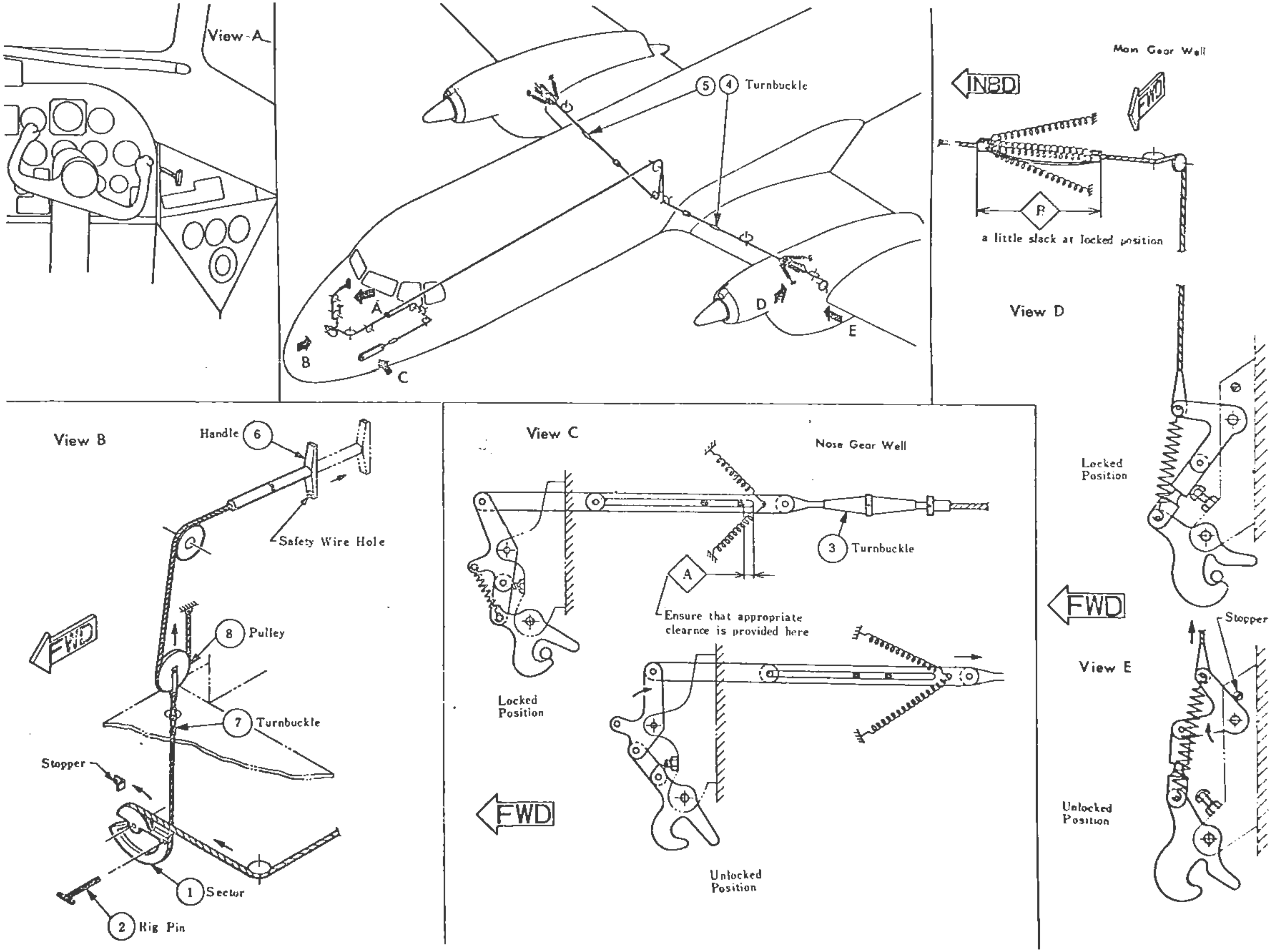


Keep this clearance to the minimum so far as the roller rotates freely.

Rigging-Nose Gear Door Actuating Mechanism
Figure 3–28



Emergency Up Lock Release System
Figure 3–29



Emergency Uplock Release System Rigging
Figure 3-30

3.5 Wheel and Brake System

3.5.1 General

This system consists of the following sub-systems:

A. Normal and Parking Brake System

B. Emergency Brake System

C. Anti-skid System

D. Wheels

Both of the normal and emergency brake systems are designed to be operated hydraulically.

With the exception of the return line, these systems are entirely separated. The anti-skid system has been built in the normal brake system.

3.5.2 Normal and Parking Brake System

(1) General

The brake is of the conventional power brake type. Brake force in proportion to the travel of the brake pedal is applied to four brakes of the main gear.

The parking brake handle is located in front of the pilot seat. When the handle is pulled after the brake pedal is depressed, the brake pedal will be locked mechanically by the parking brake system.

(2) Operation (Fig. 3-31, 3-32)

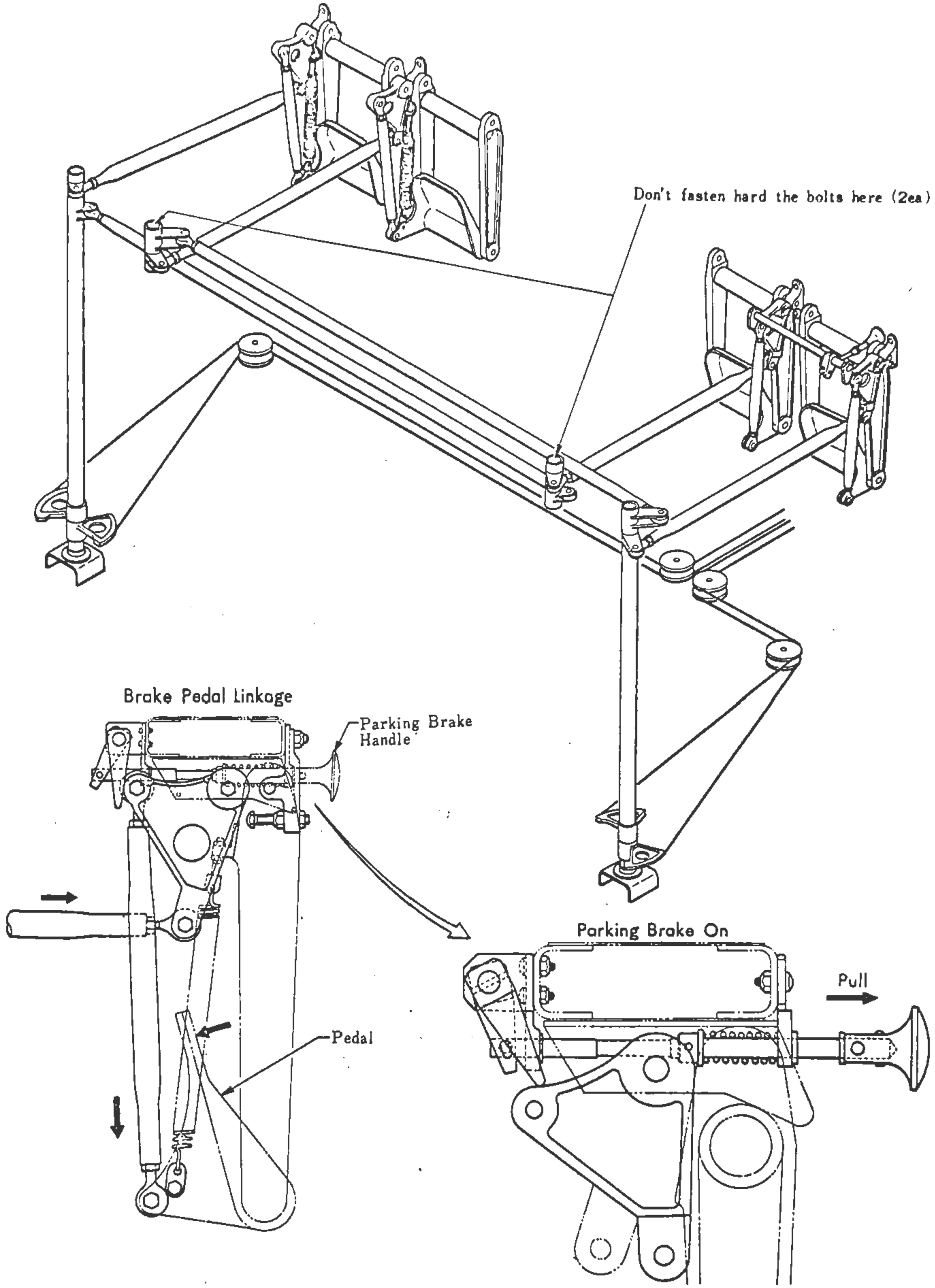
A. Depress the brake pedal, and the brake valve in the hydraulic compartment will be operated through the rod and cable.

B. Pressure oil coming from the brake valve flows to the swivel joint through the anti-skid valve. The swivel joint permits smooth extension and retraction of the gear without interfering with the pipe.

C. Pressure oil flows up to the top of the lock-out cylinder but never flows further beyond it. Hydraulic pressure, after being reduced at a ratio of 919/1000, is applied to the brake assembly. The maximum pressure to be applied is 1,200 $^{+100}_{-50}$ psi.

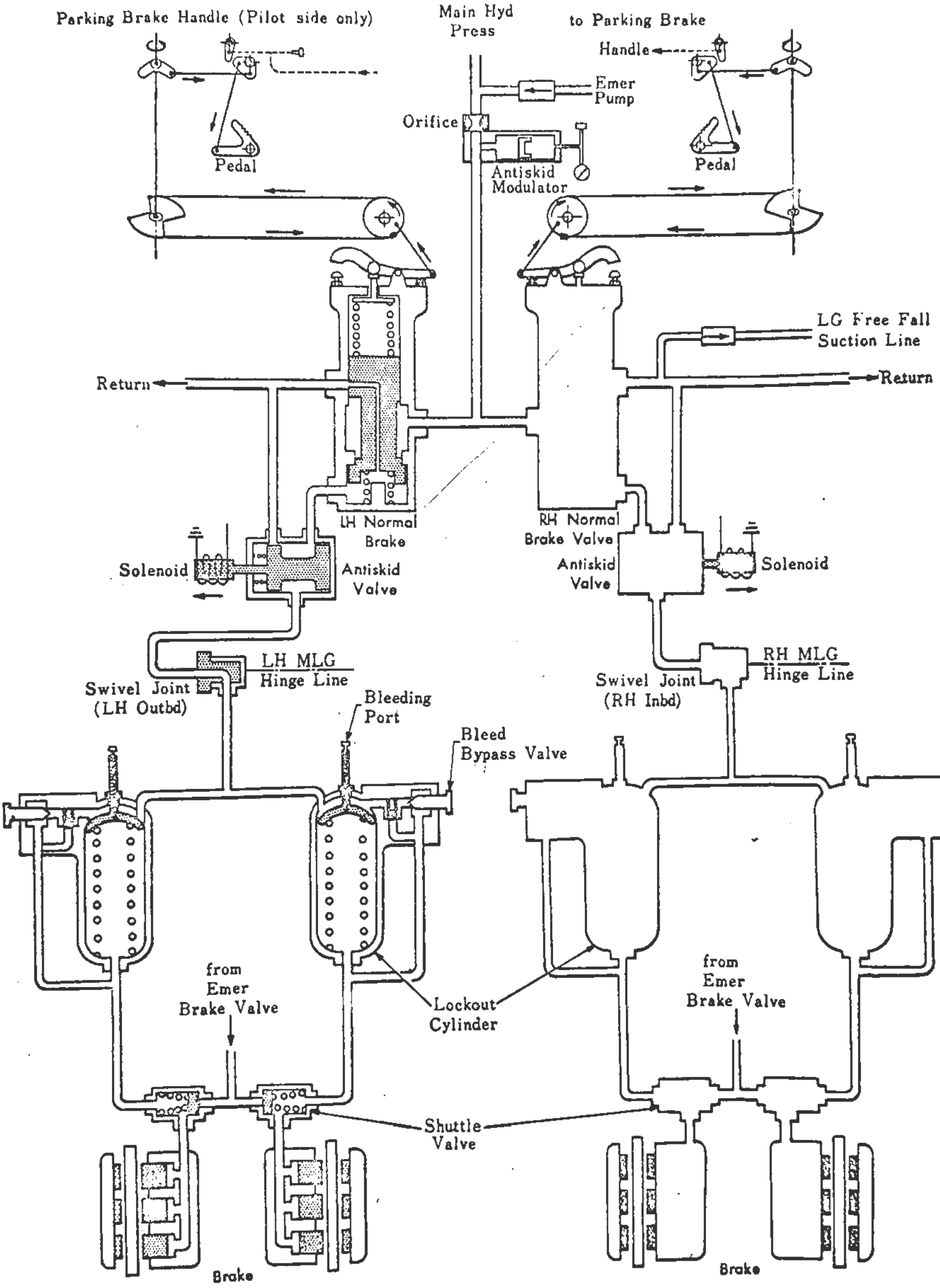
(3) Brake Valve

When the brake pedal is depressed, the roller of the lever pushes down the spring through the spring support. The spring, then, pushes down the spool supplying pressure oil to the brake port. When the

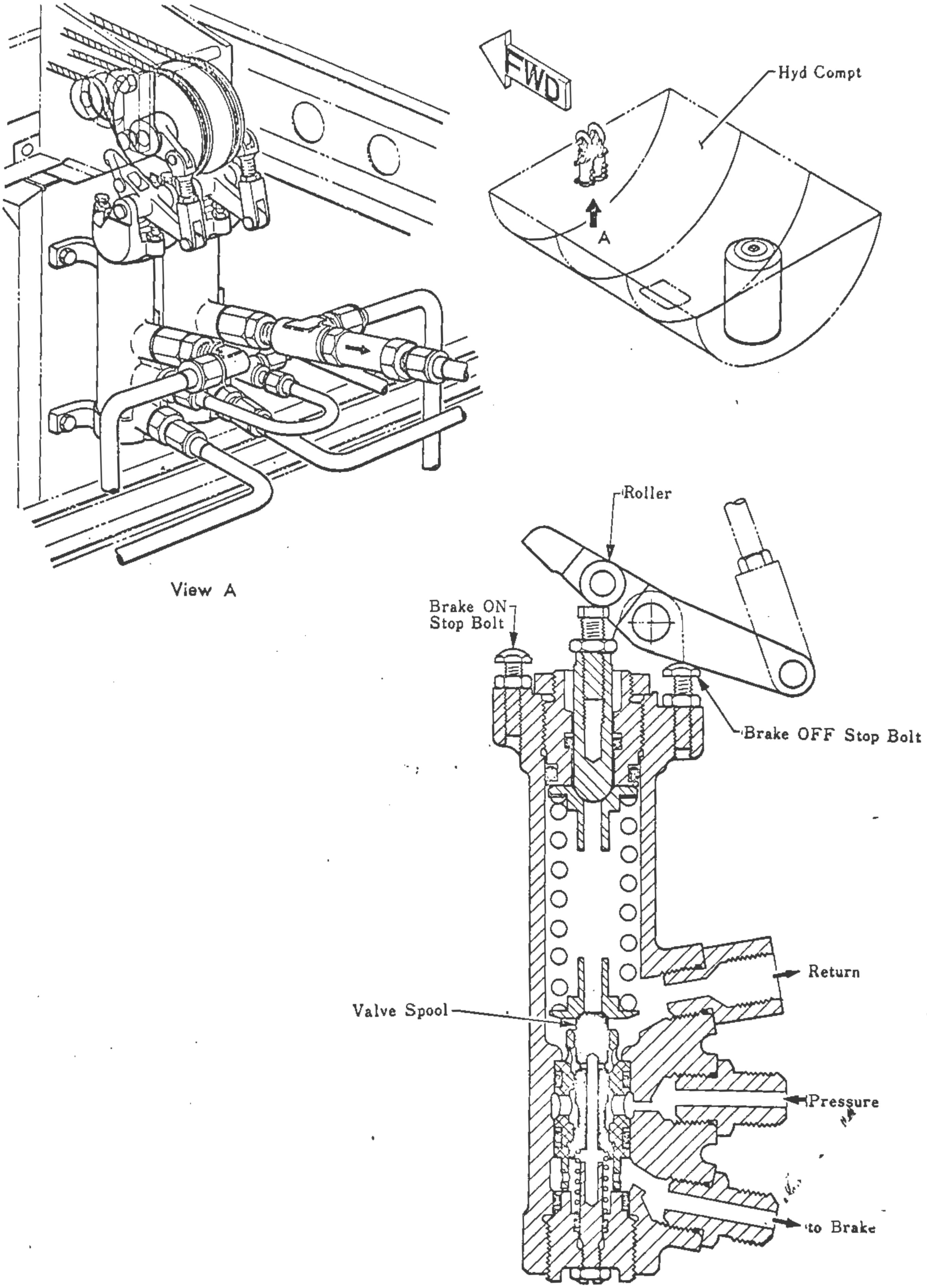


Normal and Parking Brake Linkage

Figure 3–31



Normal & Parking Brake Hyd Schematic
Figure 3–32



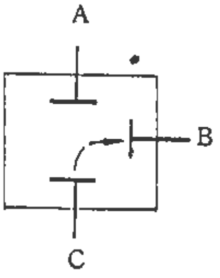
View A

Normal Brake Valve
Figure 3–33

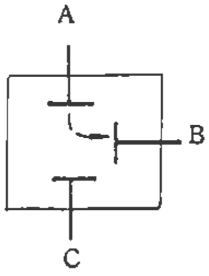
Reserved

"A" port	Down pressure line
"B" port	Landing gear actuating cylinder
"C" port	Up pressure line

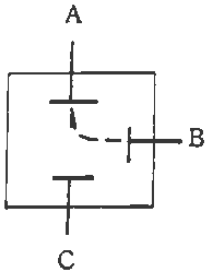
According to operations, the following circuits are made:



Gear Up



Gear Down



Free Fall

(5) Emergency Landing Gear Release Valve

The handle of the emergency landing gear release valve is located under the detachable floor of the cabin aisle.

When the selector valve is stuck at the UP position, the gear can not be lowered; therefore, this valve, shuts off pressure oil just before the selector valve and simultaneously connects the UP line to the return line.

3.4.6 Down Lock Mechanism

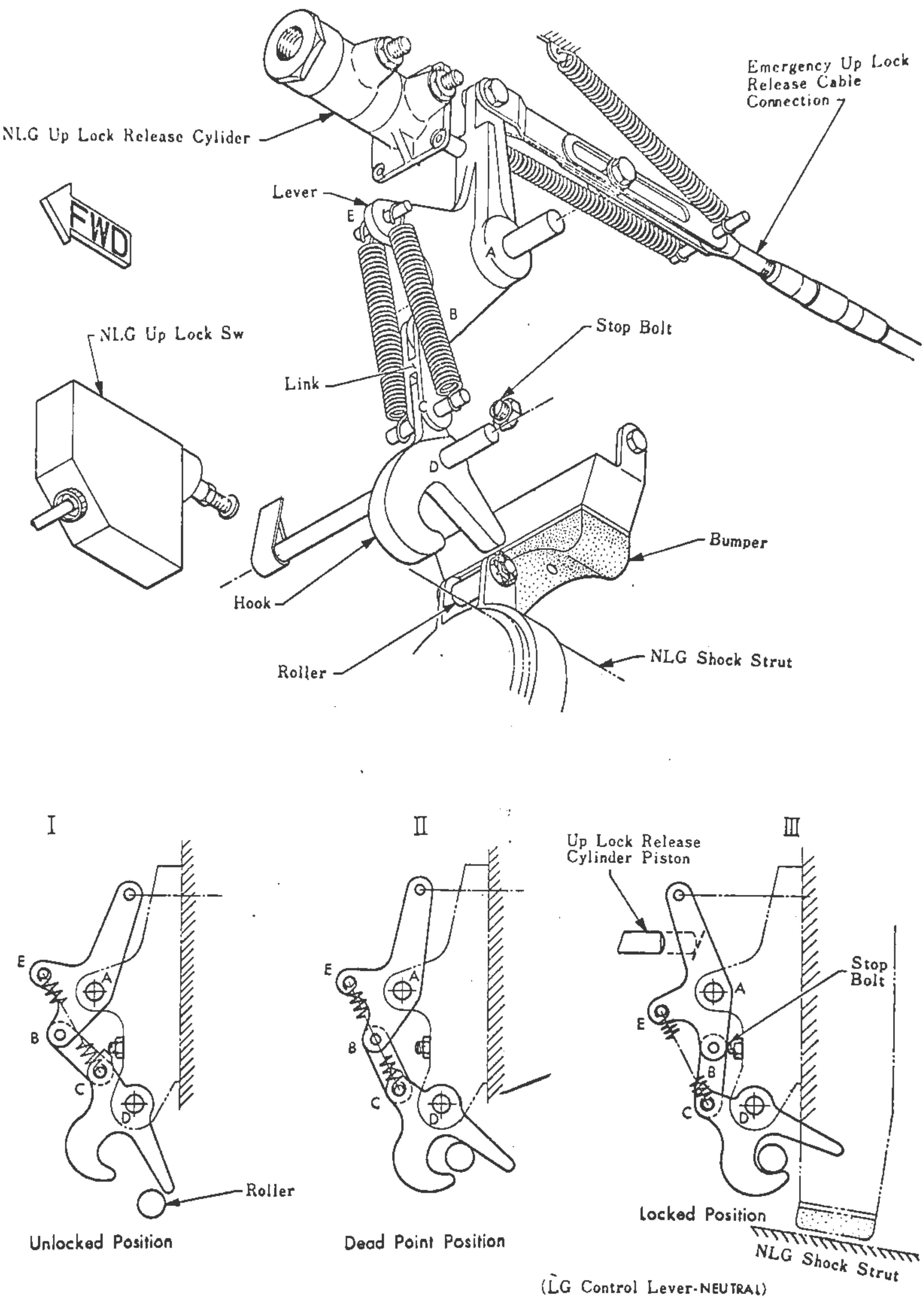
(1) General

Each gear has its own down-lock mechanism by which the gear is locked mechanically in the down-lock position and it is unlocked hydraulically. The down-lock mechanism of the main gear is almost identical to that of the nose gear; when the upper and lower drag links are in straight line, the hook fixed on the upper drag link catches the lower drag link to prevent the drag link from being folded.

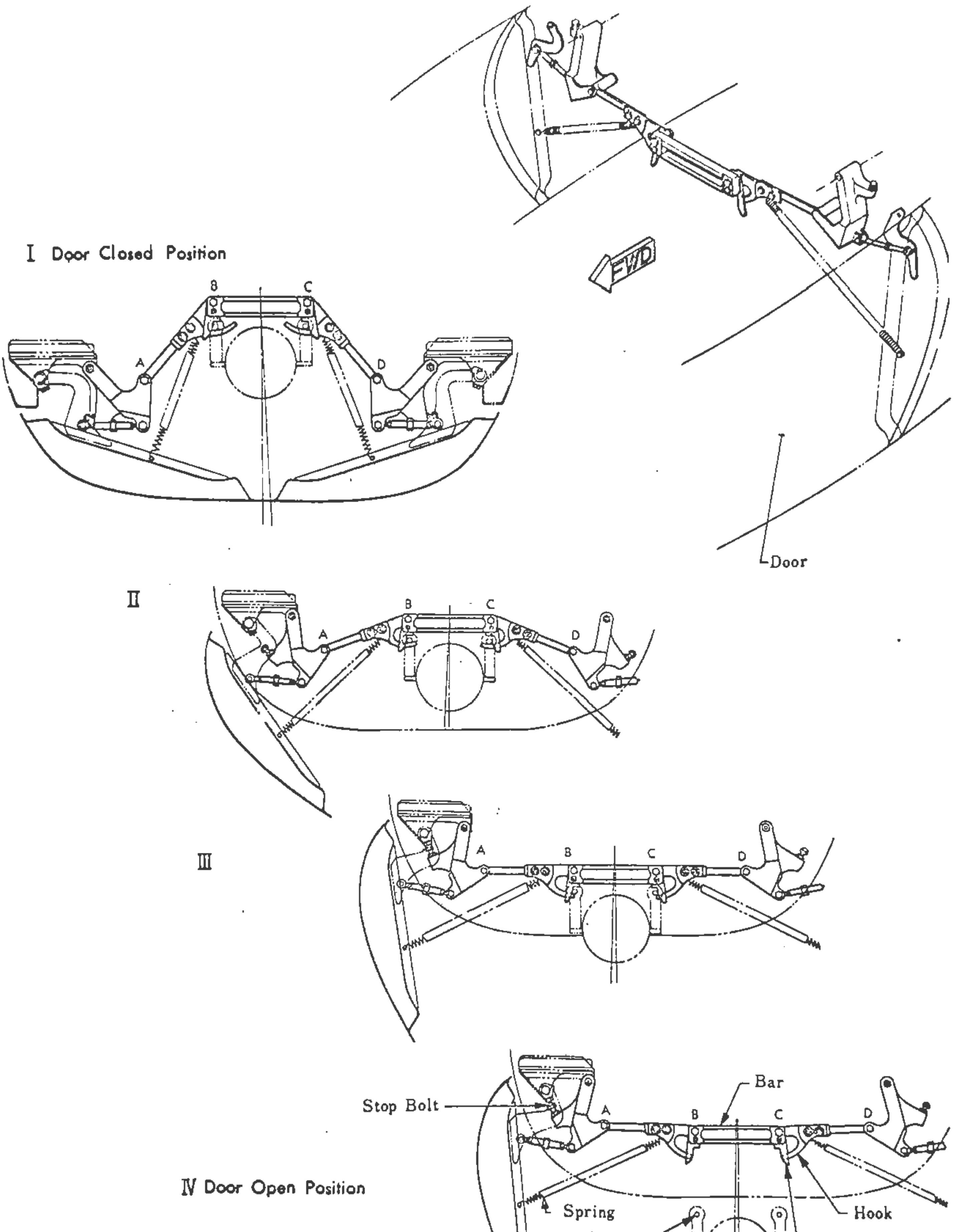
(2) Operation (Fig. 3-17, 3-18)

A,B. As the actuating cylinder retracts, the bellcrank fixed on the top of the upper drag link rotates (main 7°30', nose 5°), pulling the hook until it releases the down-lock.

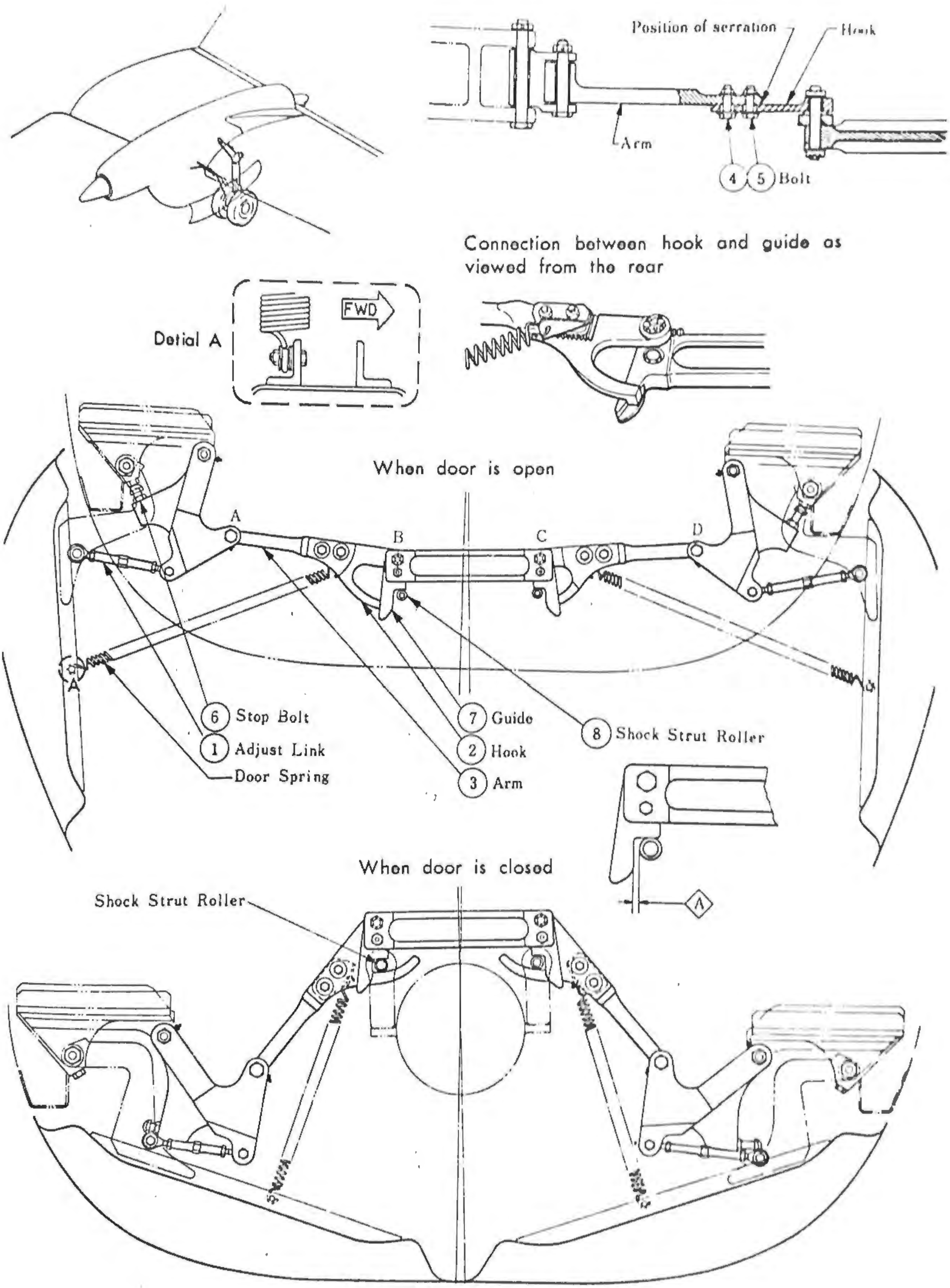
C. As the clutch is in contact with the bellcrank, the action of the actuating cylinder is transmitted to the drag link which, therefore, is folded. Subsequently, the landing gear is retracted, and the drag link also is folded automatically.



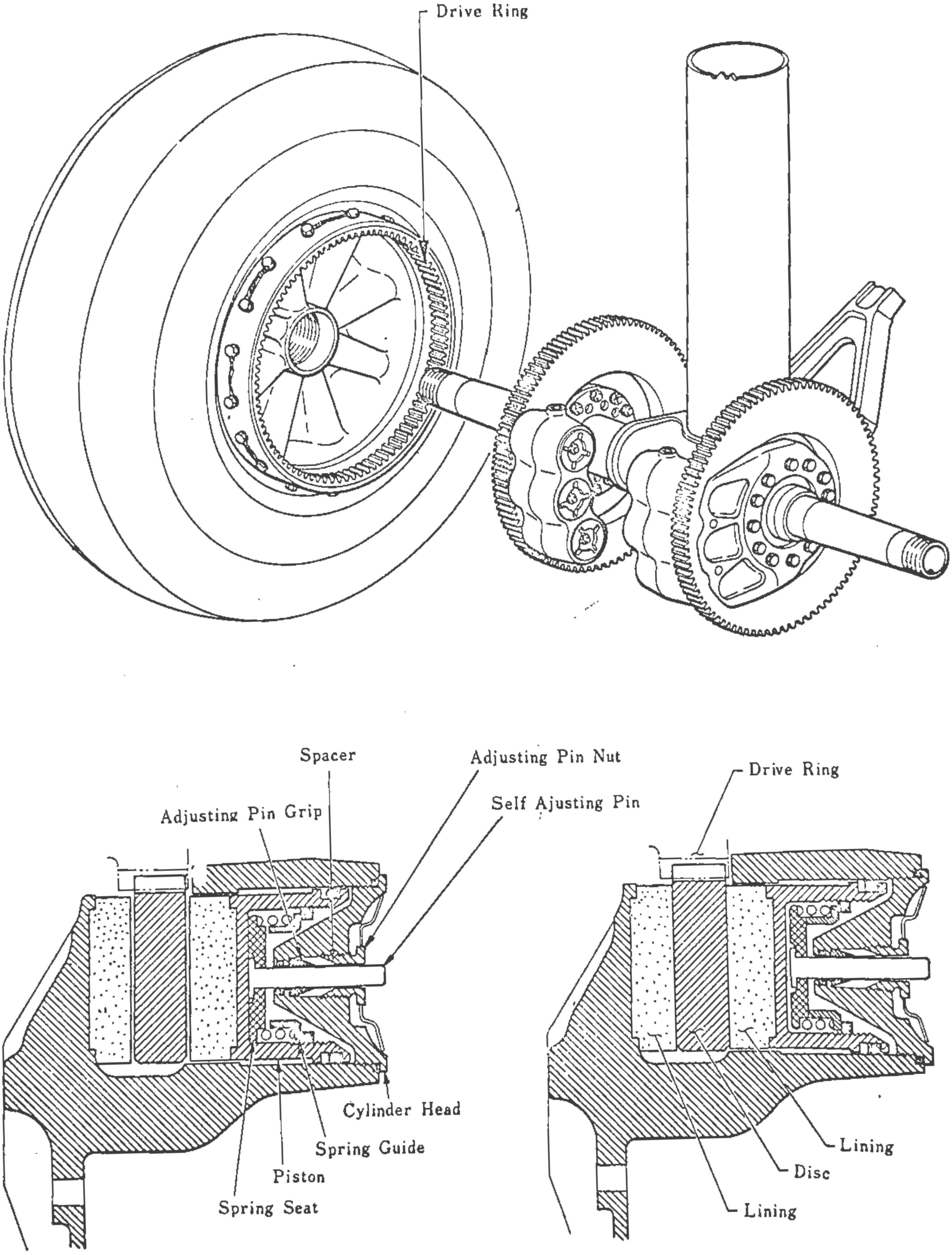
Nose Landing Gear Uplock Mechanism
Figure 3–22



Main Landing Gear Door Actuating Mechanism
Figure 3–25



Rigging-Main Gear Door Actuating Mechanism
Figure 3–26



Brake OFF

Brake ON

Brake Assembly
Figure 3–34

brake pressure is increased, the spool is forced back upward up to the neutral position where brake pressure is balanced with spring force. Thus, the normal brake valve functions to produce brake pressure proportional to pedal force.

(4) Brake Assembly

The brake is a single-plate, self-adjusting brake of such a design that three hydraulically operated pistons press a single, iron-plate disc which rotates together with the wheel.

When the brake is "ON", the pistons move inwards to press the disc. At this time, the spring contracts and the spring guide comes in contact with the spring seat. If the disc and lining are worn, the piston draws the pin inwards, shifting the spring seat inwards by the total amount of wear;
Even if the brake is released to "OFF", the pin remains at the position.

Thus, the same brake clearance is always maintained.

Wear limit of disc

a. The thinnest portion of the disc should not be less than 0.75 in (19 mm).

b. The disc weight should not be less than 29.5 lb (13.4 kg).

Wear limit of lining

a. The clearance between the disc and the shoulder of the housing on the piston side should not be more than 0.625 in(15.9 mm) with the brake "ON".

b. The thickness of the lining from its shoulder should not be less than 0.125 in (3.2 mm).

(5) Adjustment of Brake System

A. Control System Stopper

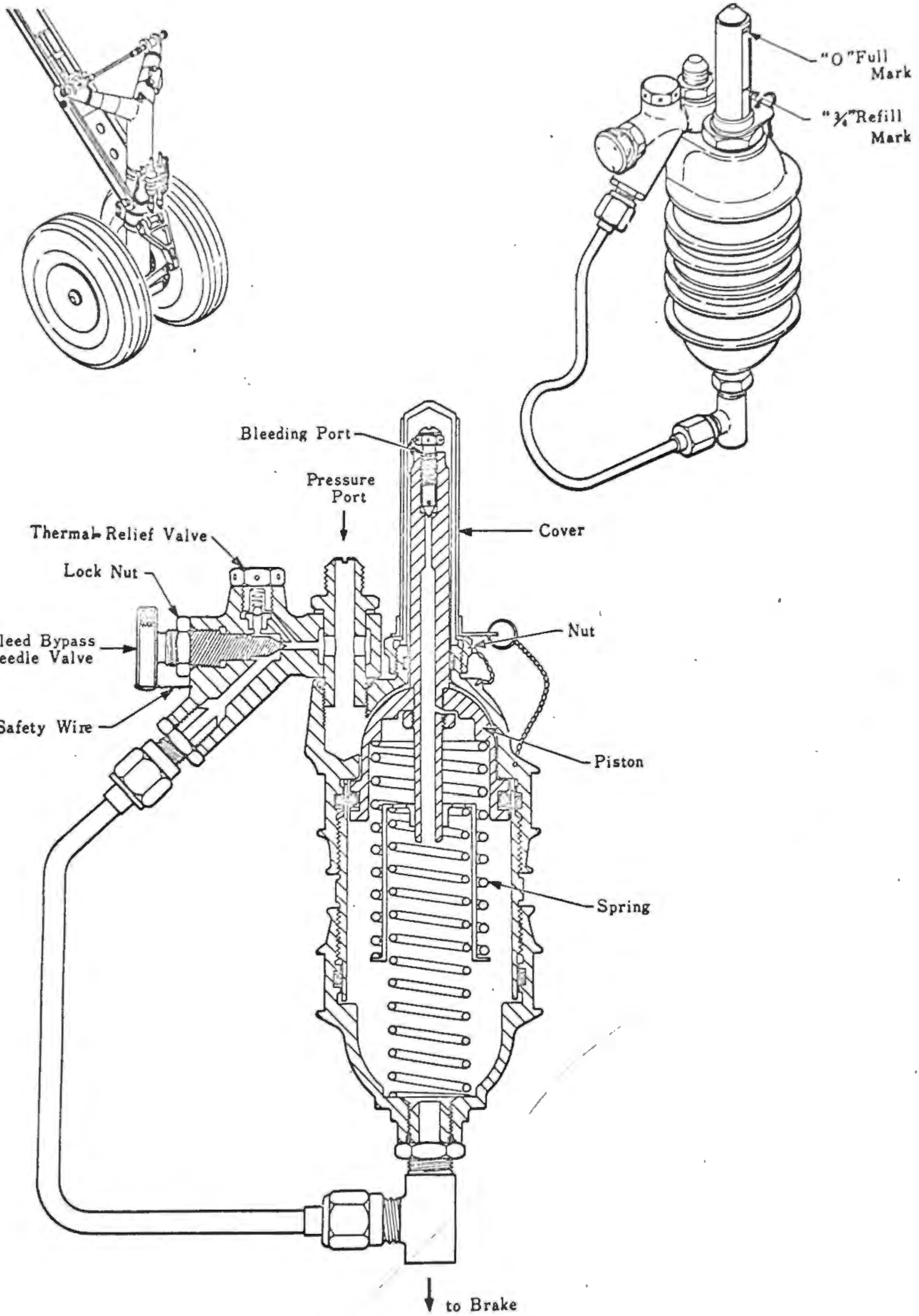
(A) Pedal Stopper (protects system)

(B) Control Valve Stopper (adjusts hydraulic pressure)

a. Brake OFF Position
b. Brake ON Position

B. Adjustment (Fig. 3-36)

(A) Adjust the length of the rods using the rig pins.



Brake Lockout Cylinder
Figure 3–35

(B) Adjust cable tension to 49.7 ± 4.4 lb at 20°C (Cable tension varies by ± 0.72 lb per 1°C)

(C) Adjust the length of the rods (3) and (4) so that rig pin (2) and the valve lever may come in proper contact with the brake-off stop bolt.

(D) Adjustment of Brake Pedal Stopper

a. Adjust the pedal stopper so that, when the pedal is depressed fully, the control valve lever comes in contact with the brake-on stopper.

b. Release the pedal, tighten the stop bolt, turning it two more turns and secure it.

(6) Function Test

Maintain hydraulic pressure at 3,000 psi and make certain the following functions:

A. The brake pressure should be proportionally related to the pedal depressing force.

(A) When the pedal pressure has reached about 10 lb, brake pressure starts to build up.

(B) When the pedal is depressed fully with about 60 lb depressing force, brake pressure should be built up to 1,200 $^{+100}_{-50}$ psi.

B. Difference in pressures to be applied to the four brake assemblies should be within 100 psi.

C. Parking brake pressure should be about 800 psi.

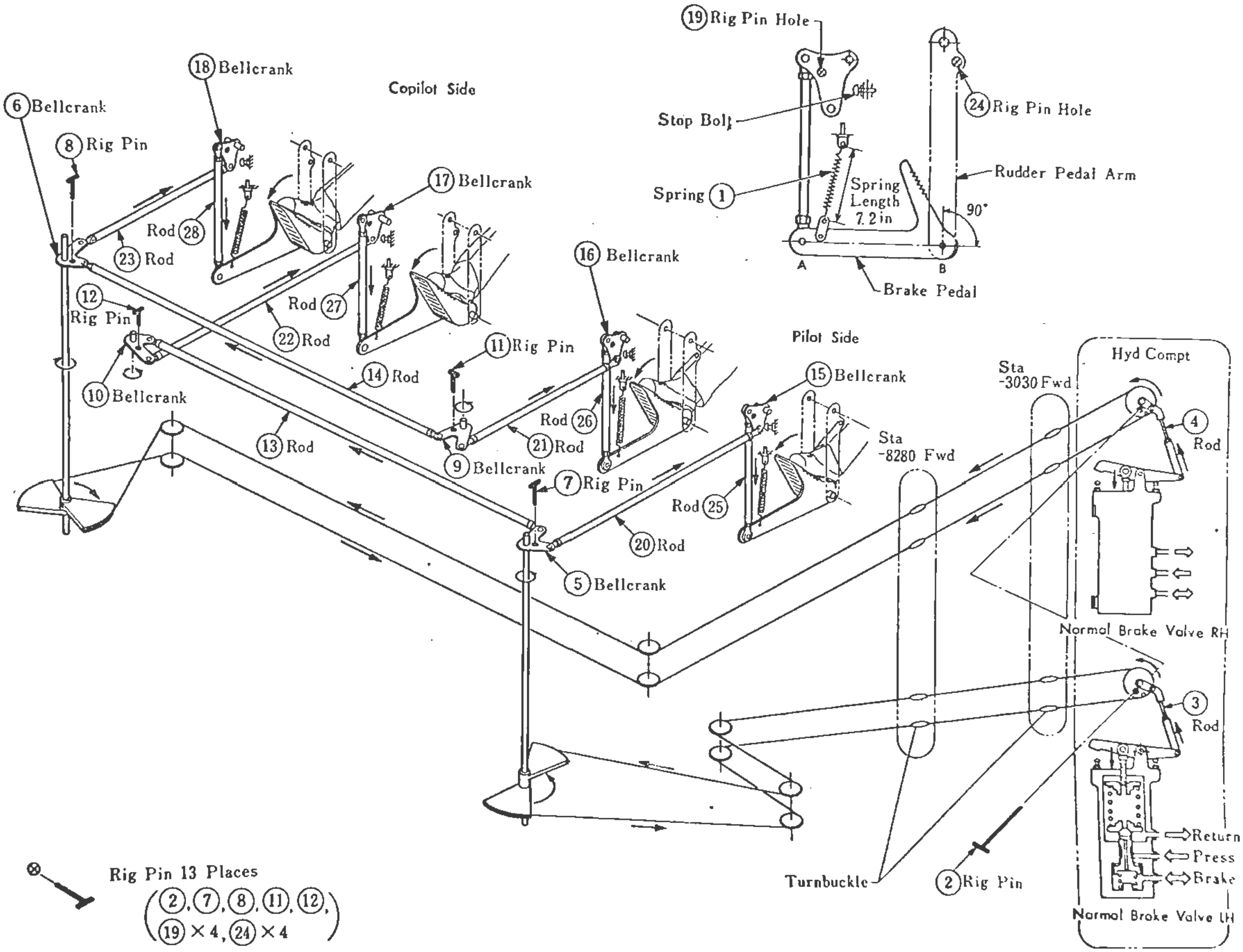
3.5.3 Emergency Brake System

(1) General

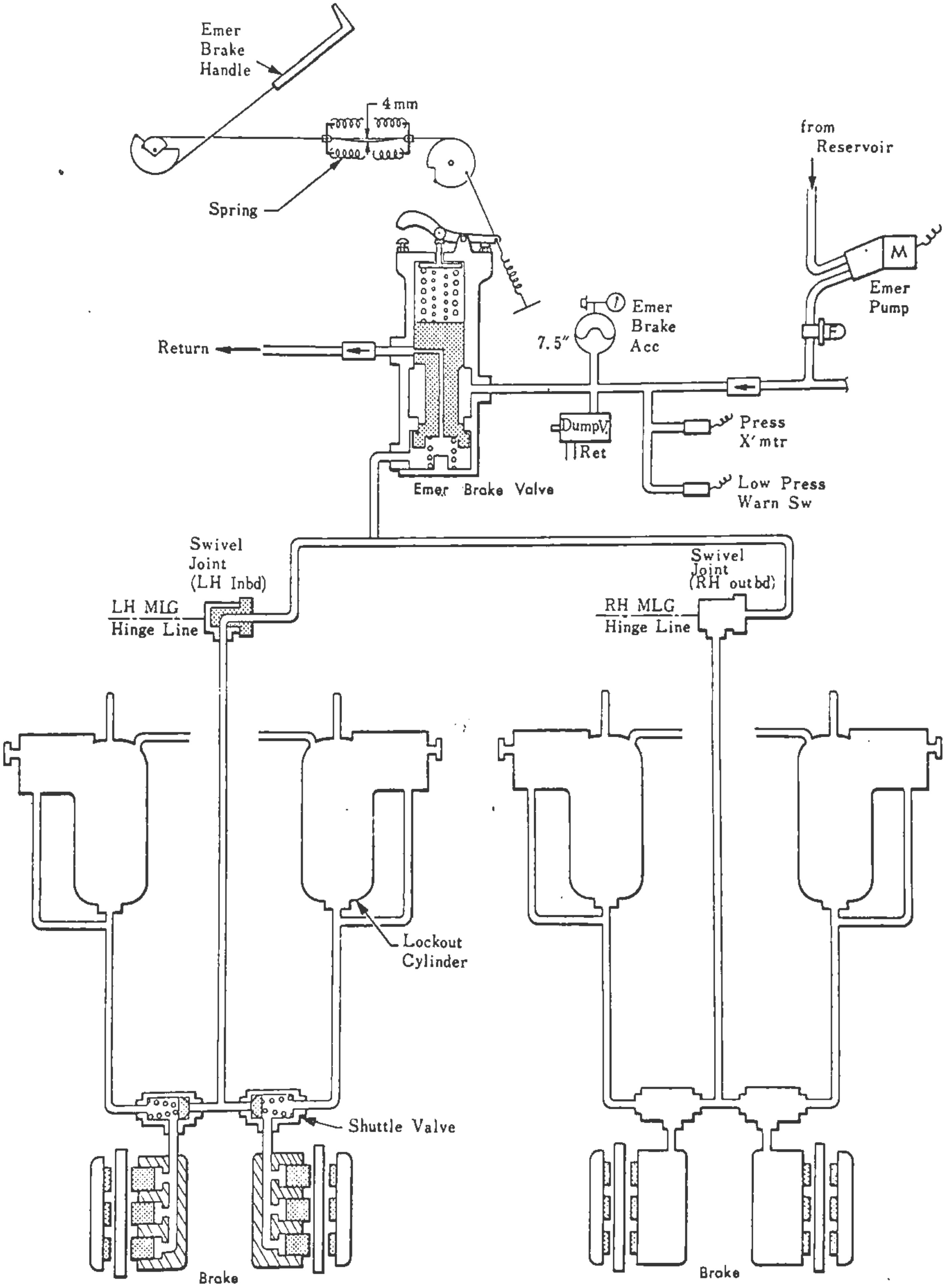
This system is an emergency braking device to be used in case of the normal brake system failure, and is operated by pulling the emergency brake handle located on the pilot side of the center pedestal. This system has its own accumulator and its hydraulic pressure is supplied by a motor driven pump. The maximum system pressure is 2,300 psi approximately two times the normal brake pressure of 1,200 psi.

(2) Operation

A. When the emergency brake handle is pulled, the valve lever is pulled up through cables and rods.



Rigging-Normal Brake System
Figure 3-36



Emergency Brake Hyd Schematic

Figure 3-36A

Reserved

B. The brake valve produces the brake pressure in proportion to the force applied to the handle. The pressure produced, passing through the swivel joint, is applied to the shuttle valve.

C. When emergency brake pressure becomes about 6 to 11 psi higher than the normal brake pressure, the shuttle valve attached to the brake assembly feeds pressure oil from the emergency brake valve to the brake assembly and, then, the normal pressure line is closed.

D. Release the handle, and the valve lever is forced back by the returning spring force to the OFF position. Brake pressure goes out to release the brake and, consequently, the shuttle valve returns to its normal position.

(3) Emergency Brake Accumulator (Fig. 3-38)

The emergency brake accumulator is of a spherical, Bendix type (7.5 in). To the tee at the top are connected the emergency brake piping and the piping for the manual damp valve. The accumulator has a capacity of 0.55 gal of hydraulic oil at 3,000 psi hydraulic pressure with air pressure of 1,000 psi.

(4) Adjustment of System (Fig. 3-37)

A. Insert the rig pin (3) in the pulley (2), and adjust the length of the rod (5) so that the valve lever may be in contact with the brake-off stop bolt (4).

B. Tighten the cable turning the turnbuckle, so that there may be some slackness of about 0.158 in (4 mm) on the spring at Fus Sta. -8730.

C. Adjust the position of the adjusting plate (7) so that the emergency brake handle can be pulled on till the valve lever comes in contact with the brake-on stop bolt (6).

(5) Function Test

Maintain the hydraulic pressure at 3,000 psi and make certain the following functions:

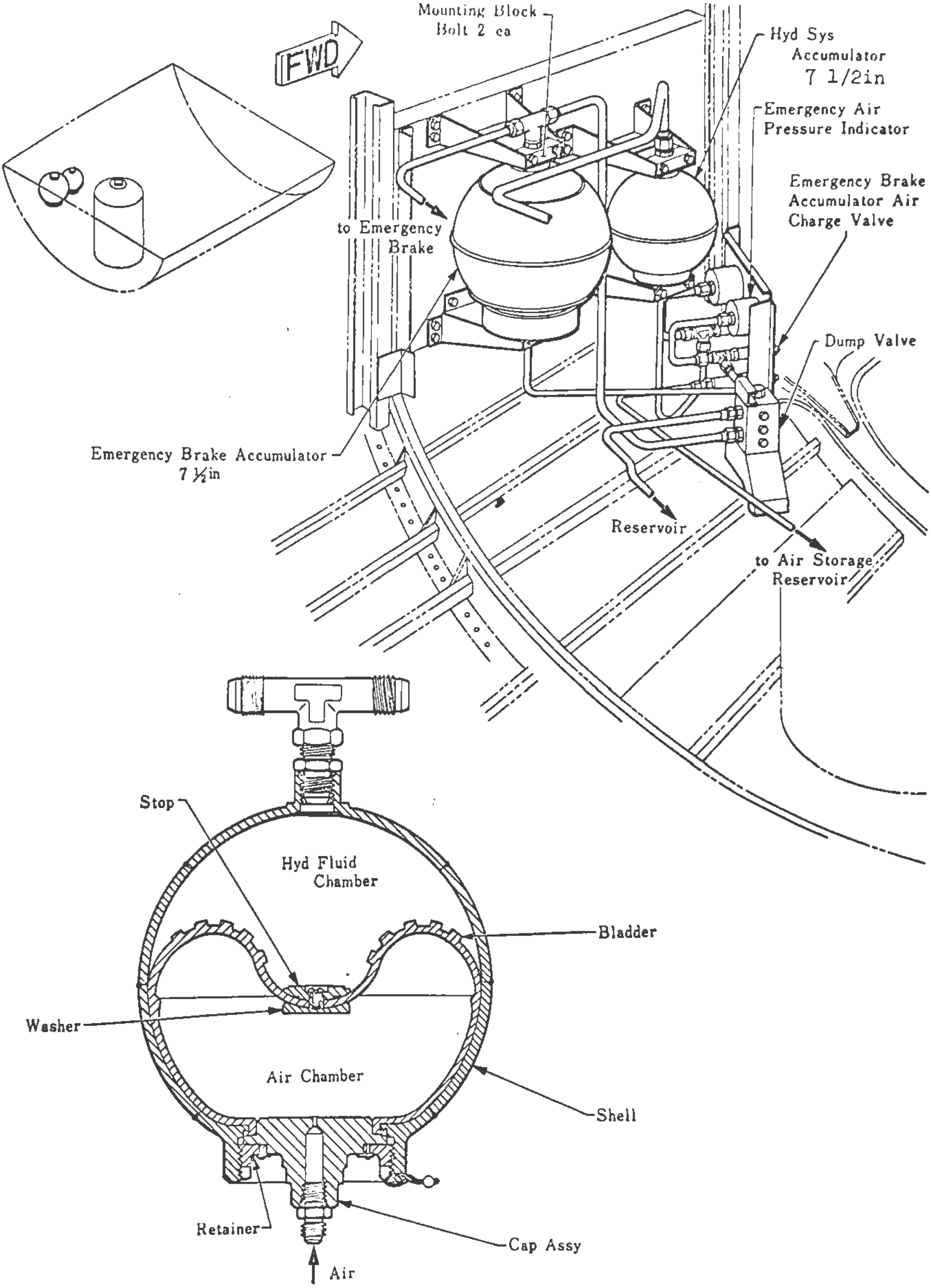
A. When the emergency brake handle is pulled fully, hydraulic pressure in the brake assembly should be $2{,}300^{+0}_{-400}$ psi.

B. When the handle is released and returned, hydraulic pressure in the brake assembly goes out.

3.5.4 Anti-skid System

(1) General

Braking is generally done between the brake disc and lining, however,



Emergency Brake Sys. Accumulator
Figure 3–38

excessive brake application causes friction between the tire and the runway surface, resulting in rapid loss of brake efficiency. (This phenomenon is called "skid")

The anti-skid system functions to minimize this phenomenon, obtaining the maximum brake efficiency.

When the anti-skid switch on the pilot flight instrument panel is set to "ON", this system controls the brake so that the pilot can keep depressing the brake pedal. In case of the system failure, the anti-skid warning light comes on.

This anti-skid system consists of the following elements:

a. Skid Detector

b. Control Box

c. Pressure Modulator

d. Anti-skid Control Valve

(2) Operation (Fig. 3-39)

A. When the anti-skid switch is turned to "ON"

(A) Fail safe relay Z is energized, storing electric power good for 3.5 sec.

(B) Consequently, the secondary power relay X_2 is energized.

(C) The power relay X_1 does not work.

(D) The recovery relay Y is energized, storing electric power good for 0.3 sec.

B. When the tire is about to skid

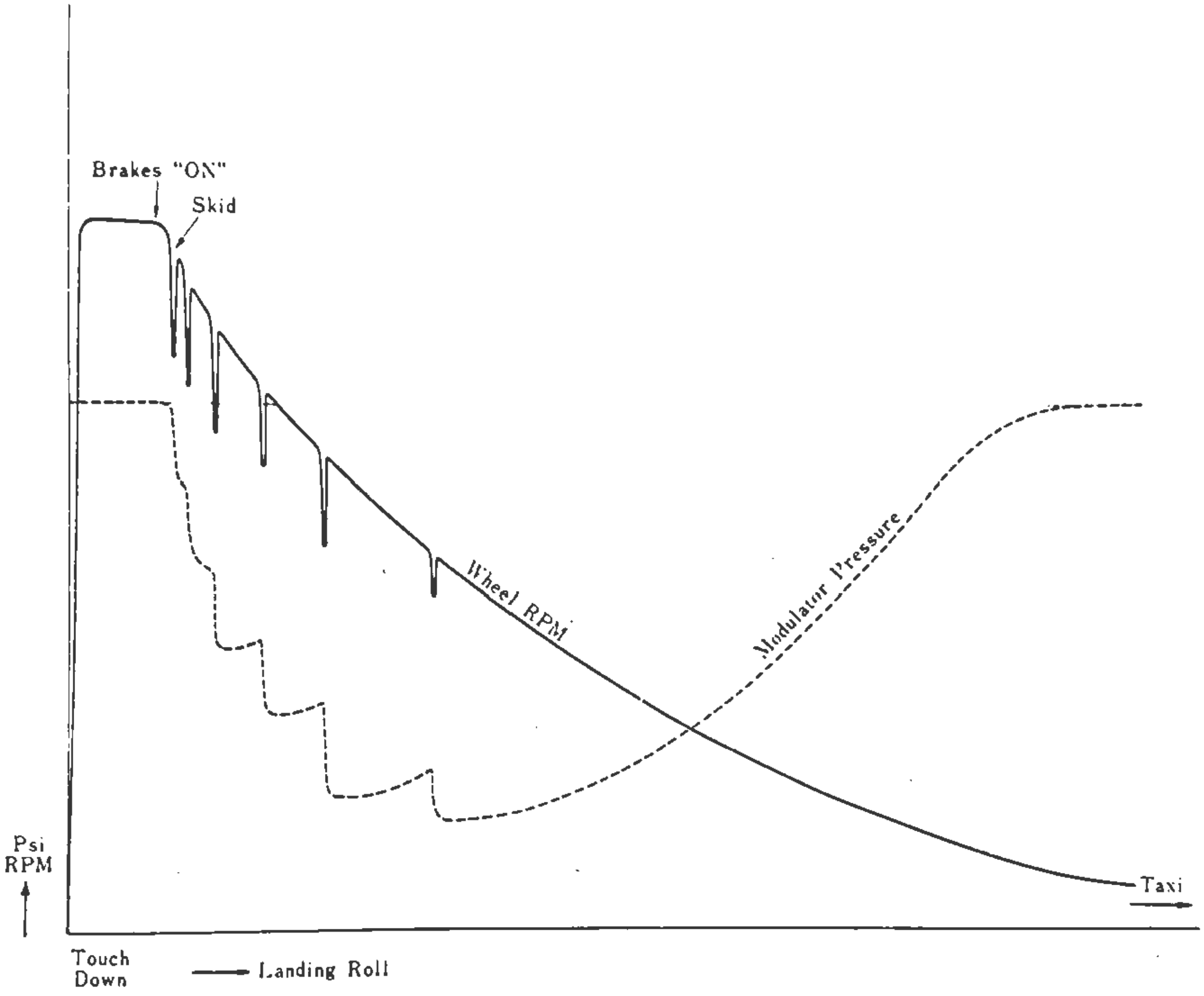
The skid detector generates skid signals.

(A) The relay X_1 is energized, supplying electric power to the anti-skid valve, returning pressure oil -- BRAKE OFF.

(B) Electric power supply to Z and Y is stopped but supply of the stored electric power to Z and Y continues.

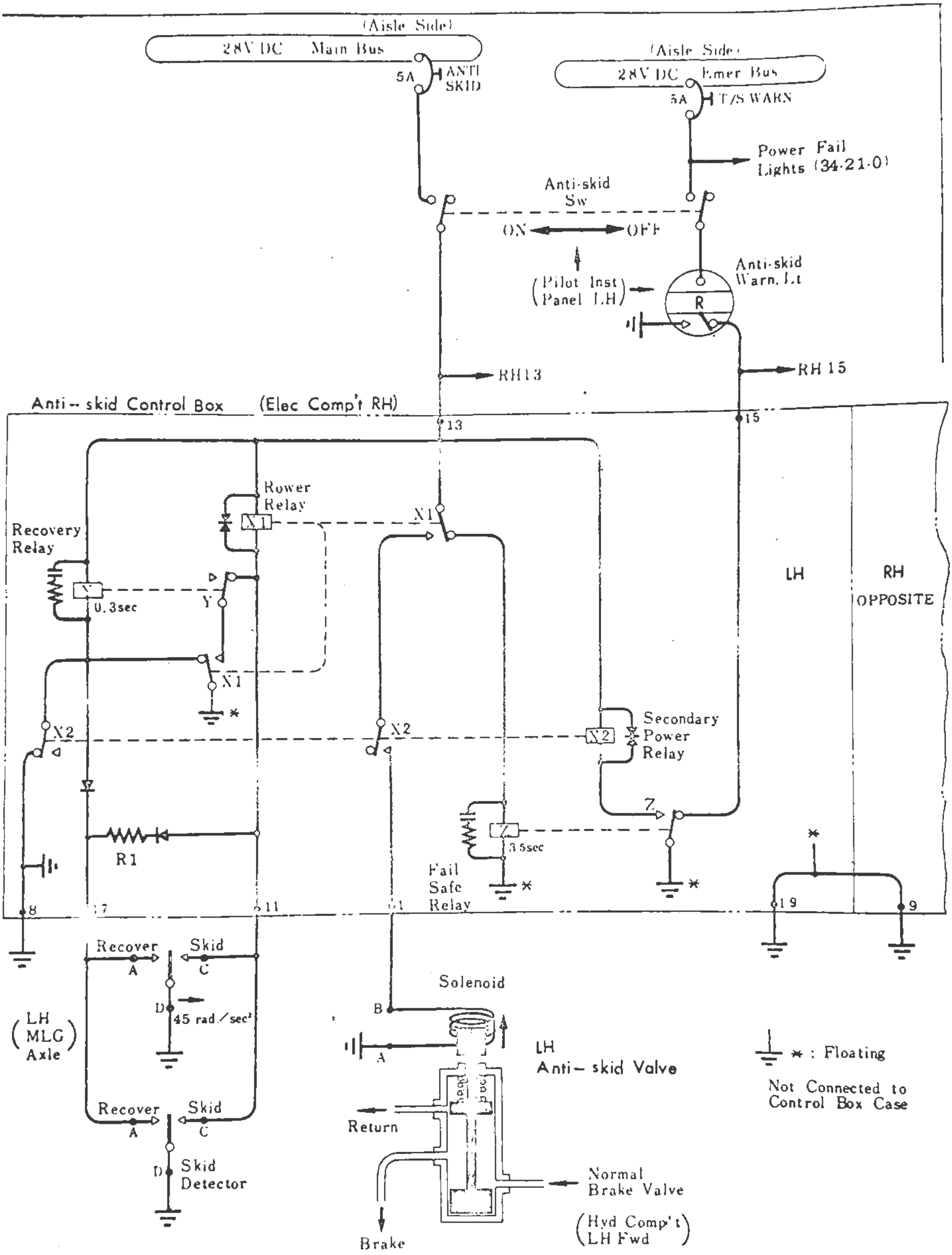
C. If the skid signal stops within 0.3 sec.

(A) X_1 is instantly switched off and the anti-skid valve returns to the BRAKE ON position.



Rough Sketch of Skid and Pressure Drop

Figure 3-39



Anti-skid Electrical System

Figure 3-39A

D. When the skid signal continues for more than 0.3 sec and stops within 3.5 sec.

(A) After the relay Y consumed the stored power, the relay X_1 makes a self-hold circuit.

(B) Thus the X_1 keeps working and the brake is kept at the OFF position even after the skid signal has stopped.

E. If the landing gear speed becomes to normal speed within 3.5 sec.

(A) The acceleration of the gear results in switching on the recover side of the detector.

(B) The relay Y is energized and breaks the self-hold circuit of the X_1.

(C) But the X_1 can not be switched off because the current which passes through R_1 is weak.

(D) When acceleration of the gear has stopped and the recovery contact is switched off, the contact of the X_1 is also switched off setting the brake to the ON position.

F. If the skid signal does not stop even after 3.5 sec.

(A) The relay Z consumes electric power, so the relay X_2 returns to zero, cutting the electric power supply to the anti-skid valve. (Brake ON)

(B) At the same time, the anti-skid warning light comes on.

(3) Skid Detector

The skid detector installed on the main gear is of an inertia switch type. If the wheel is decelerated at a rate of angular velocity over 45 rad/sec^2, this detector generates skid signal; and generates recovery signal when the wheel speed is increased suddenly.

(4) Anti-skid Control Box

This box is installed on the right-hand wall of the electric compartment.
The anti-skid control valve is controlled according to the signal and its duration from the detector.

(5) Anti-skid valve

This valve is installed on the left front corner of the hydraulic compartment under the normal brake valve. This valve is a solenoid valve, and brake pressure line comes to this valve passing through the normal brake valve. When this valve is energized from the control box, the port leading to the brake valve is closed and pressure oil goes out through the return line.

(6) Anti-skid Modulator

Brake pressure line goes to the brake valve passing through this modulator.
This modulator consists of cylindrical accumulator and orifice.
When the skid signal is generated, pressure oil stored in this modulator is consumed. Replenishment of pressure oil from pressure source is not enough due to the function of the orifice, so the amount of pressure oil consumed by the system always exceeds the amount of pressure oil replenished. Thus, pressure in the modulator drops, decreasing the brake pressure until skidding is stopped.
The filling air pressure of this modulator should be 250 ± 50 psi.

3.5.5 Wheel and Tire

(1) General

A. Wheel

(A) Magnesium alloy casting

(B) Dividable at the center into two, joined together with bolts. Between the two halves, the seal is installed.

(C) Provided with the taper roller bearings, two each.

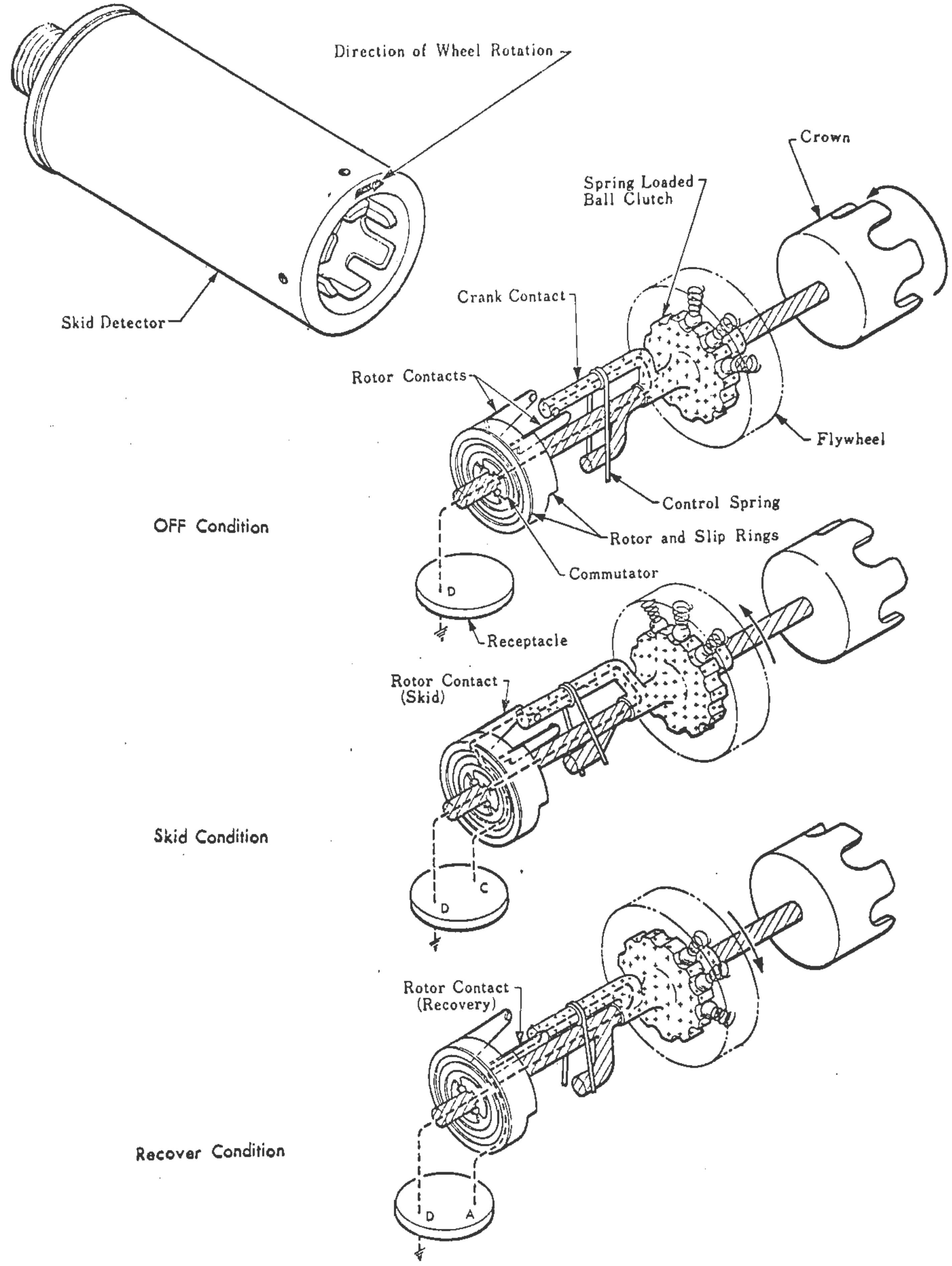
(D) No brake is installed on the nose gear.
The wheels are connected by the co-rotating shaft in the axle.

B. Tire

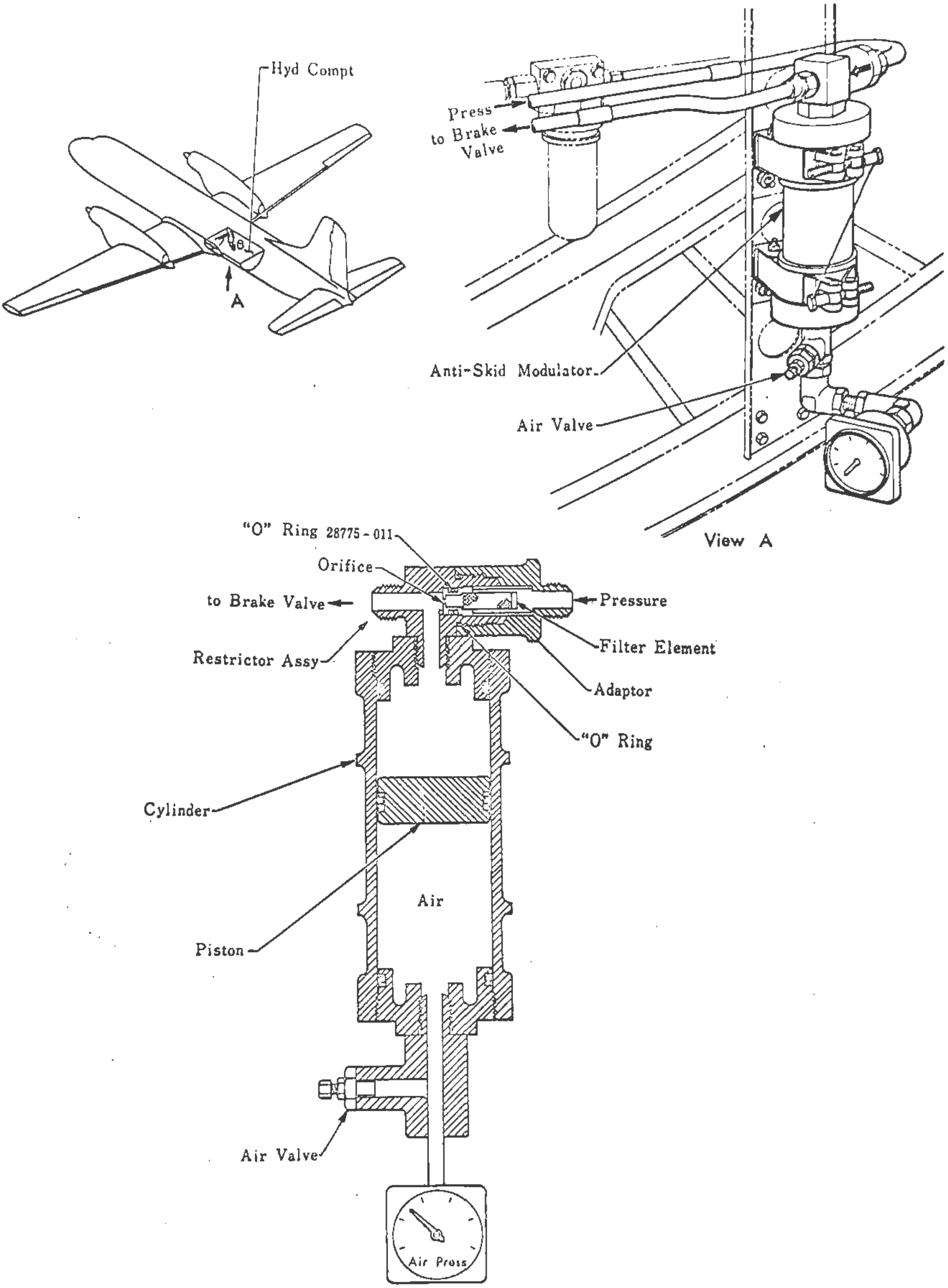
(A) Low pressure tubeless tire

(B) Type, size, etc are shown below:

	Nose Gear	Main Gear
Size	24 X 7.7	12.50 - 16
Play Rating	10	12
Type	VII	III
Beed Bandle	2 X 28	2 X 48
Pressure	50 psi	75 psi



Skid Detector
Figure 3–40



Anti-Skid Modvlator

Figure 3—41

3.6 Steering System

3.6.1 General

Steering operation can be done by turning the steering handle installed on the left-hand console in the cockpit.

Turn the steering handle, and the valve of the steering unit attached to the nose shock strut is turned through a cable allowing pressure oil to turn the torque link. The lower end of the torque link is connected to the nose gear inner cylinder, therefore, the inner cylinder is turned, steering the nose gear.

The proportion of the handle turning angle to steering angle is four to one (4 : 1). The maximum steering angle is 50 degrees on either side.

3.6.2 Operation

Hydraulic pressure from the down line of the gear is supplied to the steering unit through the filter.

The steering unit consists of a valve and cylinder; when the steering handle is turned, the valve is moved by the cable allowing pressure oil to flow to the cylinder.

The rack of the piston rotates the collar gear (torque arm rotates) and the nose gear is steered.

(1) Neutral

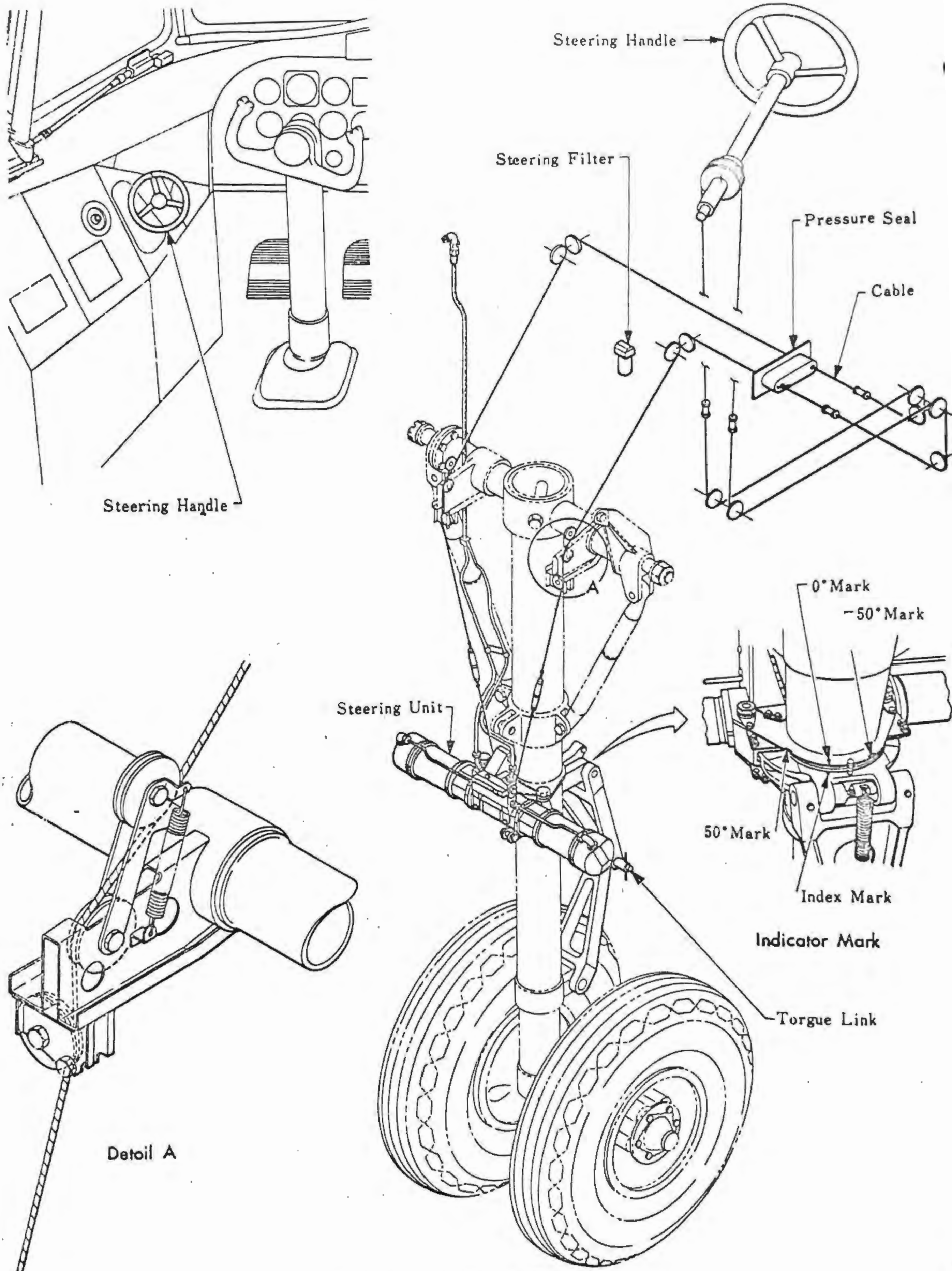
The steering handle is positioned at the center and the arm is vertical. The piston remains at the center, therefore, the torque link is situated behind the shock strut. The wheels face the front. This is the neutral position before starting operation.

(2) When the Handle Is Turned to Right.

Since the piston still remains unmoved, the right cable is pulled and the left one is slackened. As the result, the double pulley is pushed leftwards and the arm is tilted. At this time, the valve spool is also moved leftwards by the yoke. Then, hydraulic pressure oil enters the left side of the cylinder, starting to move the piston towards the right.

(3) When the Piston Moves Rightwards.

The rack turns the collar gear and the wheel gradually steer to the right. The cable end attached to the piston also moves to the right together with the piston pulling the slackened left-hand cable and, on the contrary, slackening the pulled right-hand cable. As the difference in tension between the left and right cables decreases, the yoke returns to the original vertical position.



Nose Wheel Steering System

Figure 3–42

When the nose wheel steers to the right at such an angle as proportional to the handle turning angle, the valve returns to the neutral position and the nose wheel stops at this angle.

3.6.3 Adjustment (Fig. 3-44, 3-45)

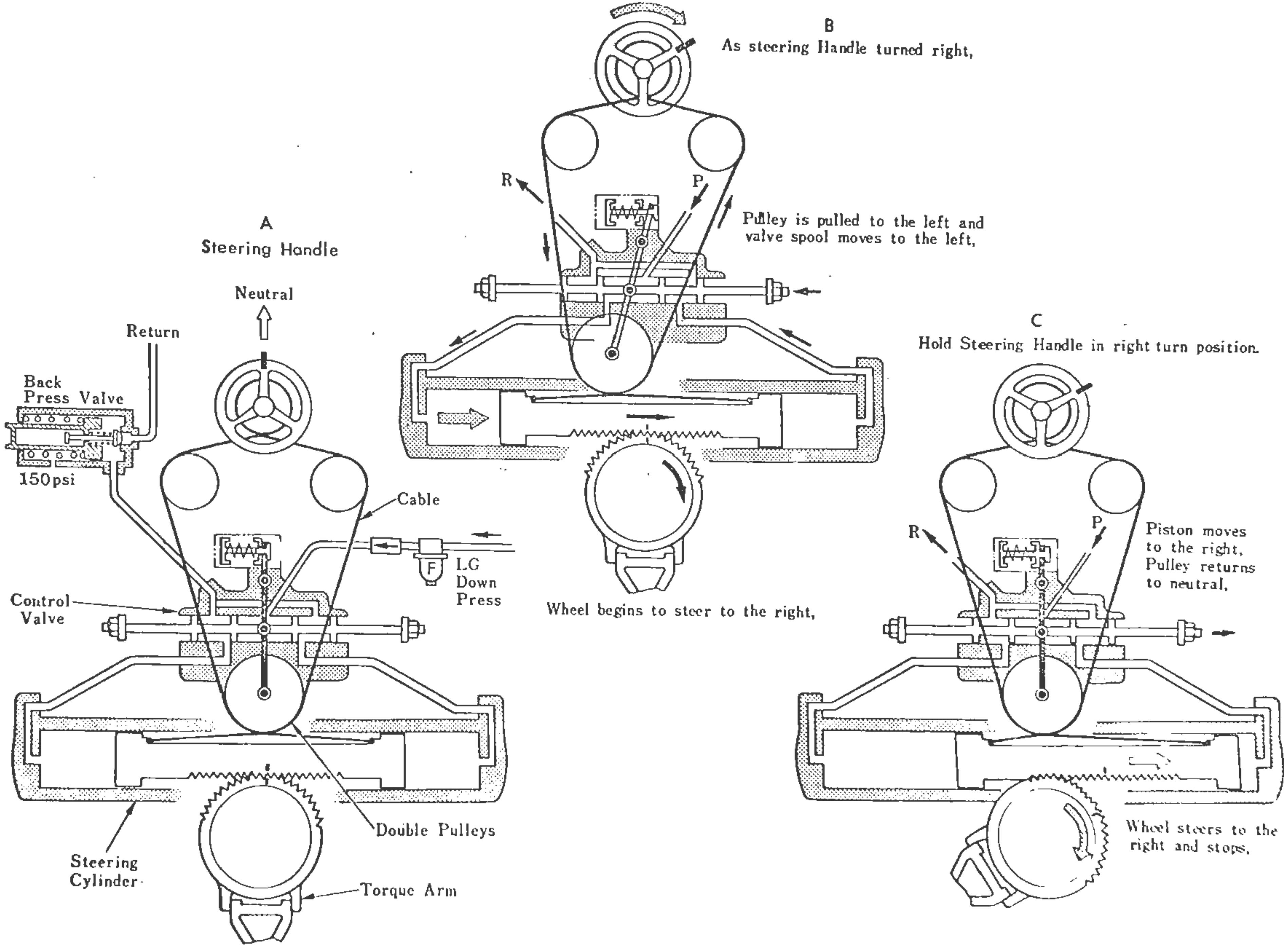
(1) Insert the rig pins (1) and (2), and, turning the turnbuckle, adjust the cable tension to 24.3 ± 2.2 lb at 20°C. (Cable tension varies by ±0.7 lb per 1°C)

(2) Increase hydraulic pressure and, operating the steering handle, make certain that the torque link can be moved smoothly.

(3) Make certain that, when the handle is set at the neutral position, the torque link also stops at the corresponding position; and, when the handle is turned fully to the left and right, the torque link also turns 50° ± 3° to either side.

(4) Adjust the stop bolt (4) in Fig. 3-45, so that the clearance ◇1 is within the specified limits.

(5) Make certain that, when the torque link is moved with the hydraulic pressure on, the steering handle turns freely, following the movement of the torque link.


A
Steering Handle
Neutral
Return
Back Press Valve
150psi
Cable
LG Down Press
F
Control Valve
Double Pulleys
Steering Cylinder
Torque Arm
B
As steering Handle turned right,
R
P
Pulley is pulled to the left and valve spool moves to the left,
Wheel begins to steer to the right,
C
Hold Steering Handle in right turn position.
R
P
Piston moves to the right, Pulley returns to neutral,
Wheel steers to the right and stops,

Nose Wheel Steering Control System
Figure 3-43

NOTE: THIS APPLYS TO N214P AND N218P ONLY.

Steering System

3.

1. GENERAL

In order to make turning on the ground in smaller space possible, the following modification is accomplished, whereby the minimum turning radius is reduced smaller by increasing the maximum steering actuating angle from its' standard value of 50°, up to 60°.

(1) The overall length of the steering cylinder is increased to obtain a longer stroke, and at the same time the pitch circle diameter of the pinion gear is reduced. (New P/N 01-72027-1)

(2) To compensate for the resultant change in the installation of the steering cylinder and in the stopper angle, the cylinder of the nose landing gear, and the steering cylinder control valve cover are modified.

(3) Modification is made to eliminate interference between the nose gear doors and other components, due to the increased length of the steering cylinder.

(4) The stopper is modified to accept the increased actuating angle of the steering handle. (New P/N 01-81752-3)

Turn the steering handle, and the valve of the steering unit attached to the nose strut is turned through a cable allowing pressure oil to turn the torque link. The lower end of the torque link is connected to the nose gear inner cylinder, therefore, the inner cylinder is turned, steering the nose gear.

The proportion of the handle turning angle to steering angle is four to one (4:1). The maximum steering angle is 60 degrees on either side.

2. ADJUSTMENT

(1) Insert the rig pins (1) and (2), and turning the turnbuckle, adjust the cable tension to 24.3 ± 2.2 lb at 20°C. (Cable tension varies by ± 0.7 lb per 1°C)

(2) Increase hydraulic pressure and, operating the steering handle, make certain that the torque link can be moved smoothly.

(3) Make certain that, when the handle is set at the neutral position, the torque link also stops at the corresponding position; and, when the handle is turned fully to the left and right, the torque link also turns $60^\circ \pm {}^{0.5^\circ}_{1.5^\circ}$ to either side.

(4) Adjust the stop bolt (4) in Fig. 2, so that the clearance ◇1 is within the specified limits.

(5) Make certain that, when the torque link is moved with the hydraulic pressure on, the steering handle turns freely, following the movement of the torque link.

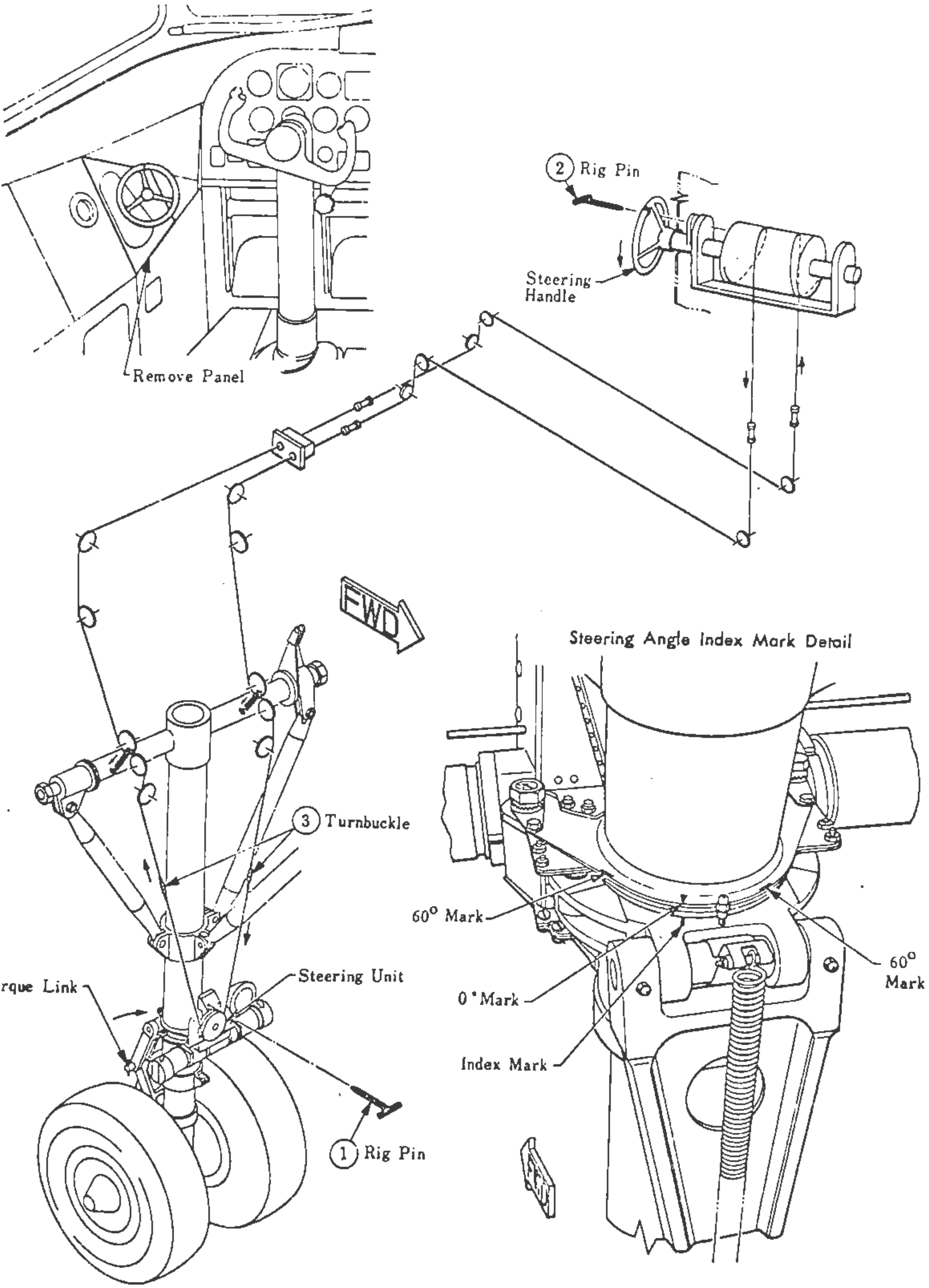


Fig 1 Rigging-Steering System

NOTE: THIS APPLYS TO
N214P AND N218P
ONLY.

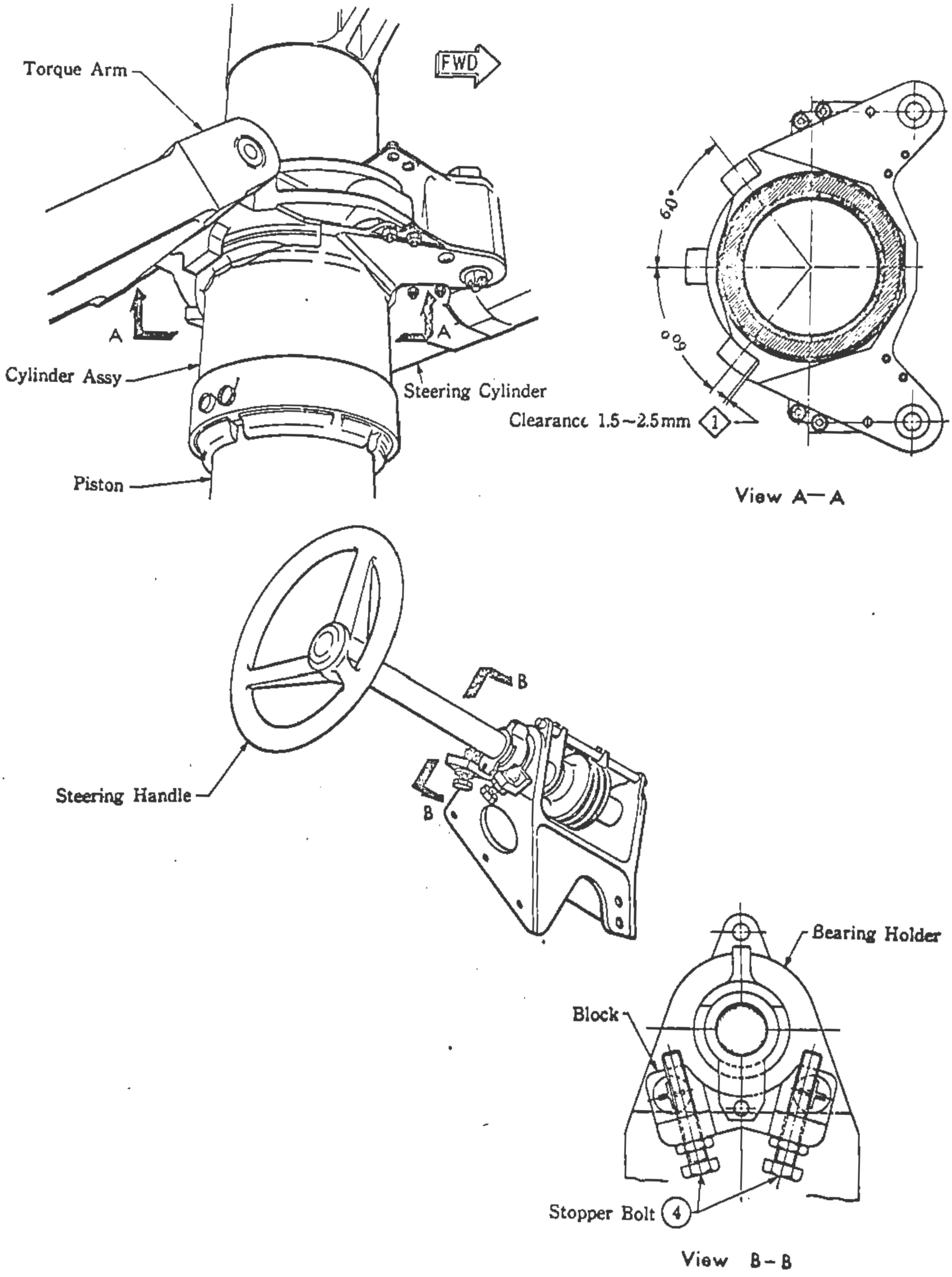
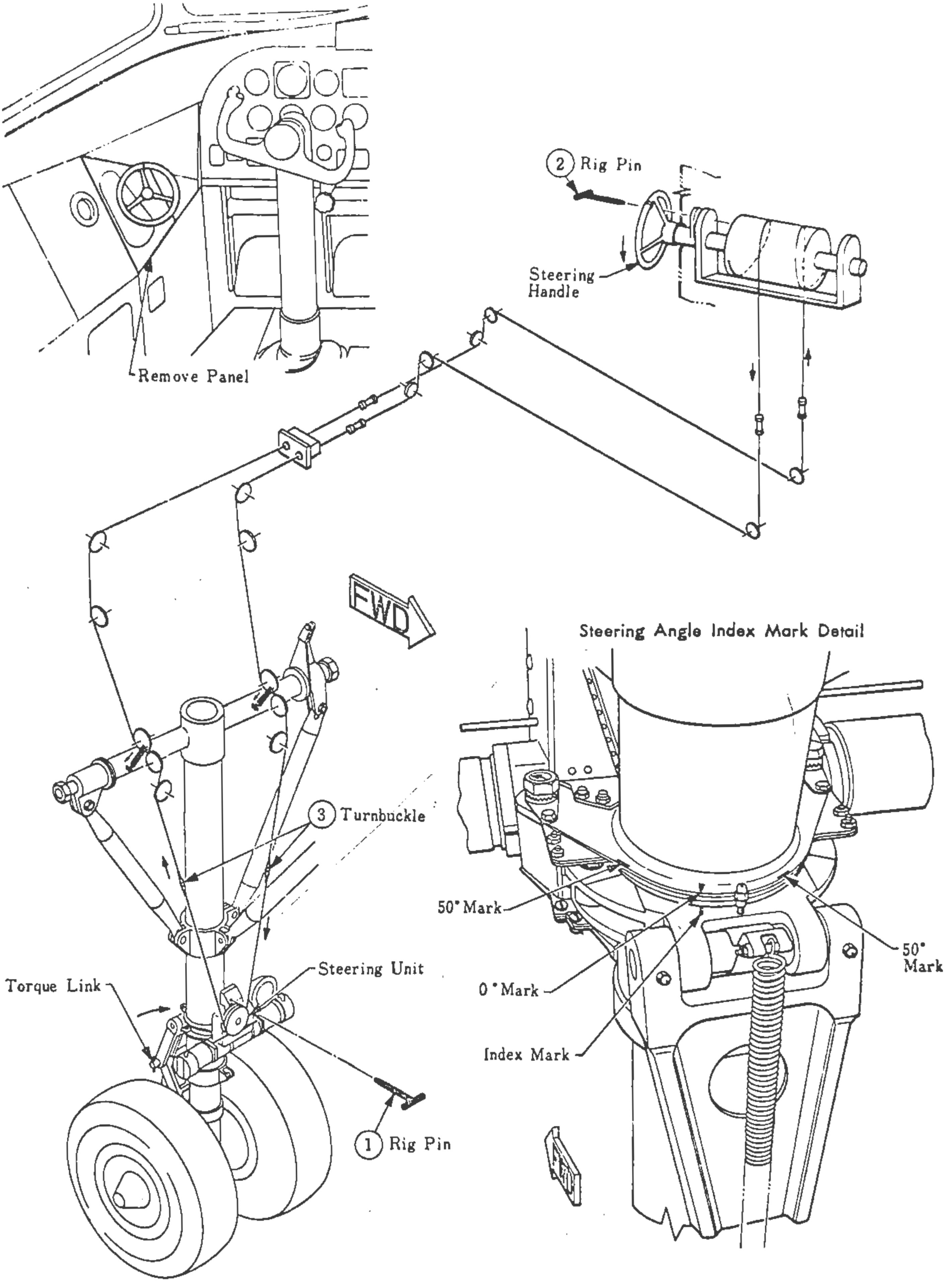
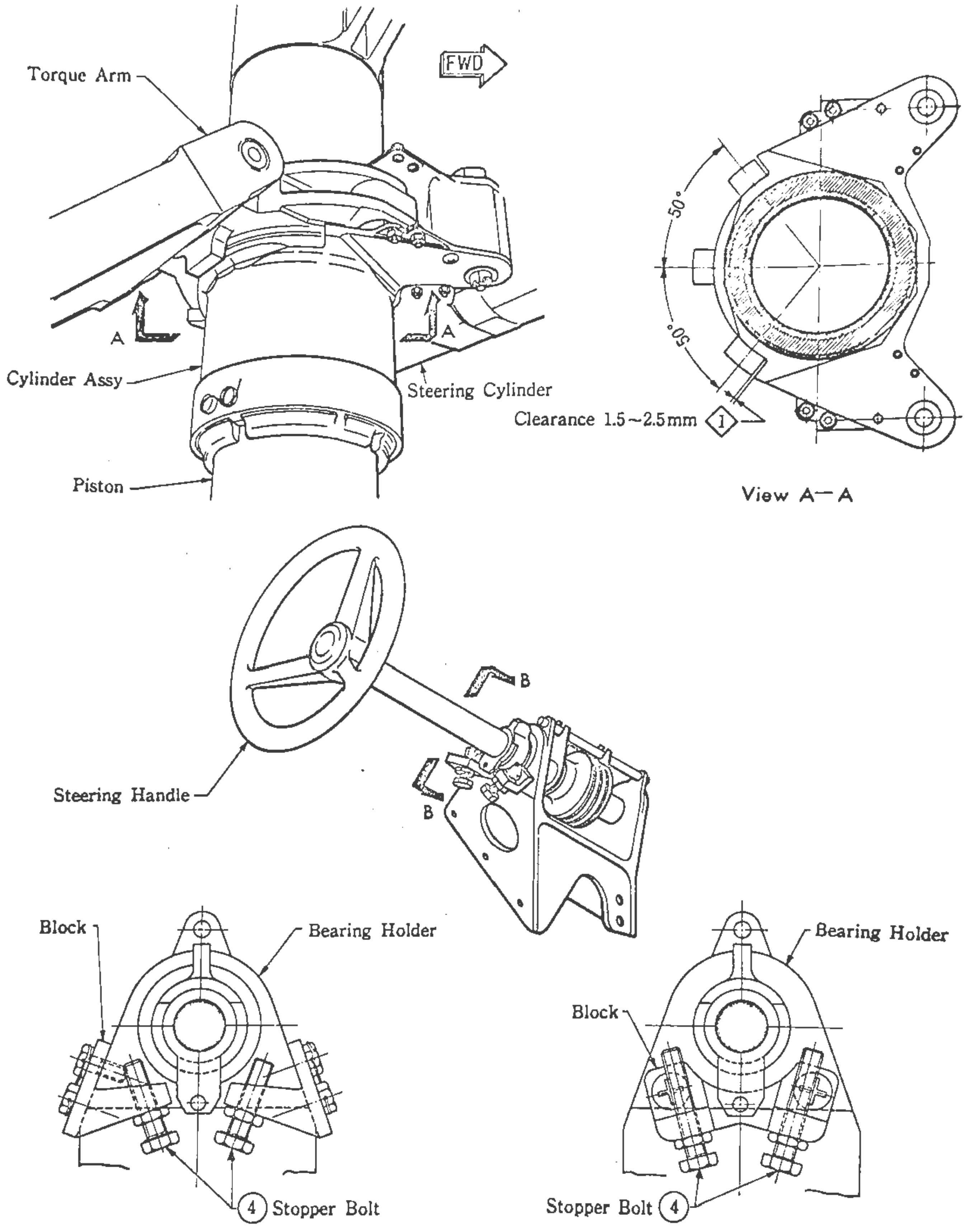


Fig 2 Rigging-Steering System



Rigging–Steering System
Figure 3–44

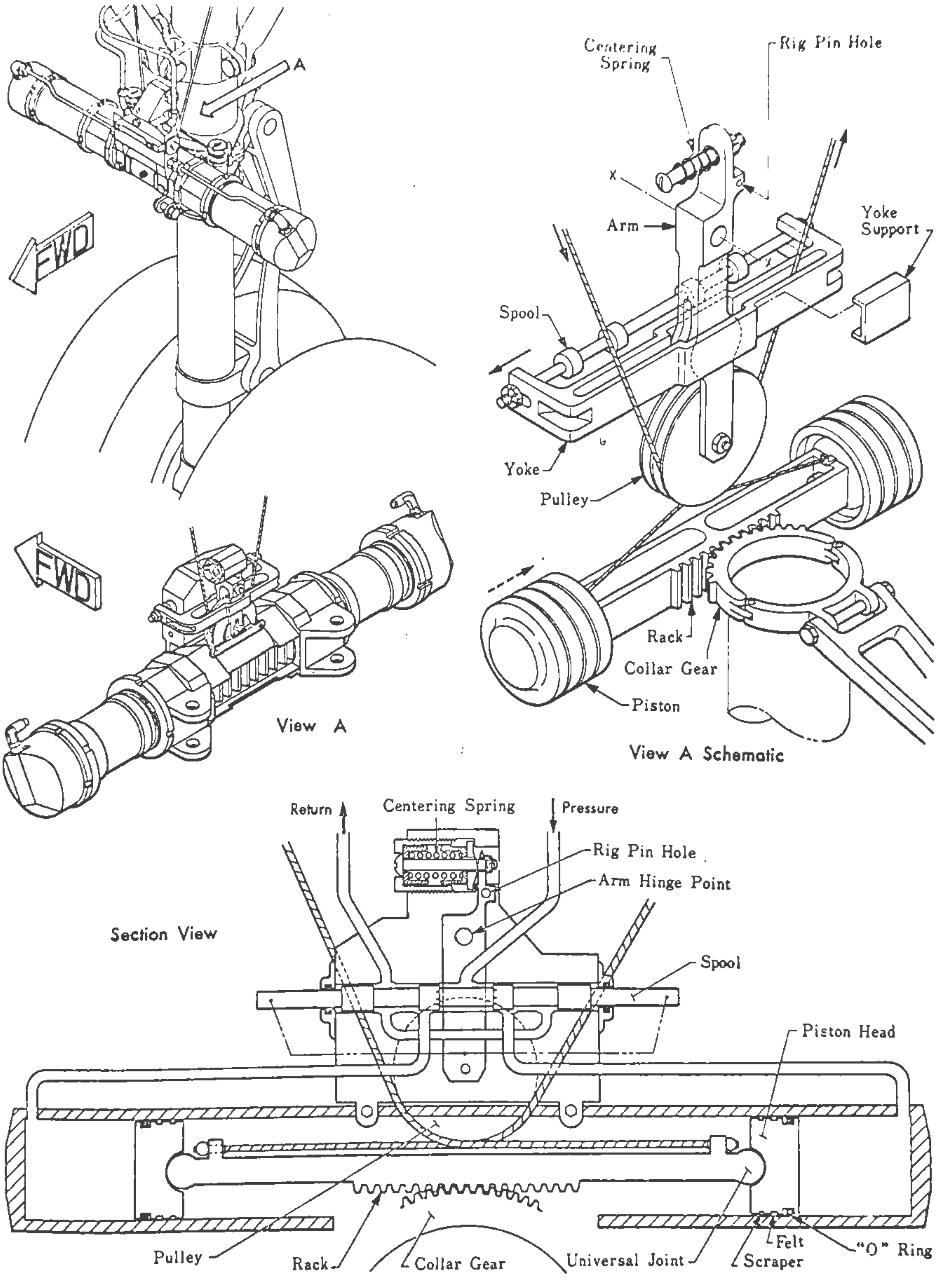


View A— A

View B – B
Applicable to ~ #2028 which S/B 32-44 has been affected

View B – B
Applicable to #2029 ~

Rigging-Steering System
Figure 3—45



Nose Wheel Steering Unit

Figure 3-46

3.7 Landing Gear Position Indication and Warning System

This system is for the indication of the landing gear position and warning, and consists of the following three systems:

A. Landing Gear Indication and Warning System

B. Main Gear Down Lock Visual Check System

C. Nose Gear Down Lock Visual Check System

3.7.1 Landing Gear Indication and Warning System

This system consists of the following three sub-systems, all of which operate on electric power from the DC emergency bus.

(1) Landing Gear Position Indicator

The position of the landing gear is indicated by three green lamps and one red lamp. When the three gears are extended and locked at the DOWN LOCK position, the down-lock switch fixed to the top of the lower drag link of each gear is pressed by the down-lock hook and three green lamps come on.

If one gear is not down-locked, the corresponding green lamp does not come on and the red lamp comes on.

When the three gears are retracted and locked at the UP LOCK position, each up-lock switch is pressed by its link mechanism and the circuit is broken, and all four lamps go out.

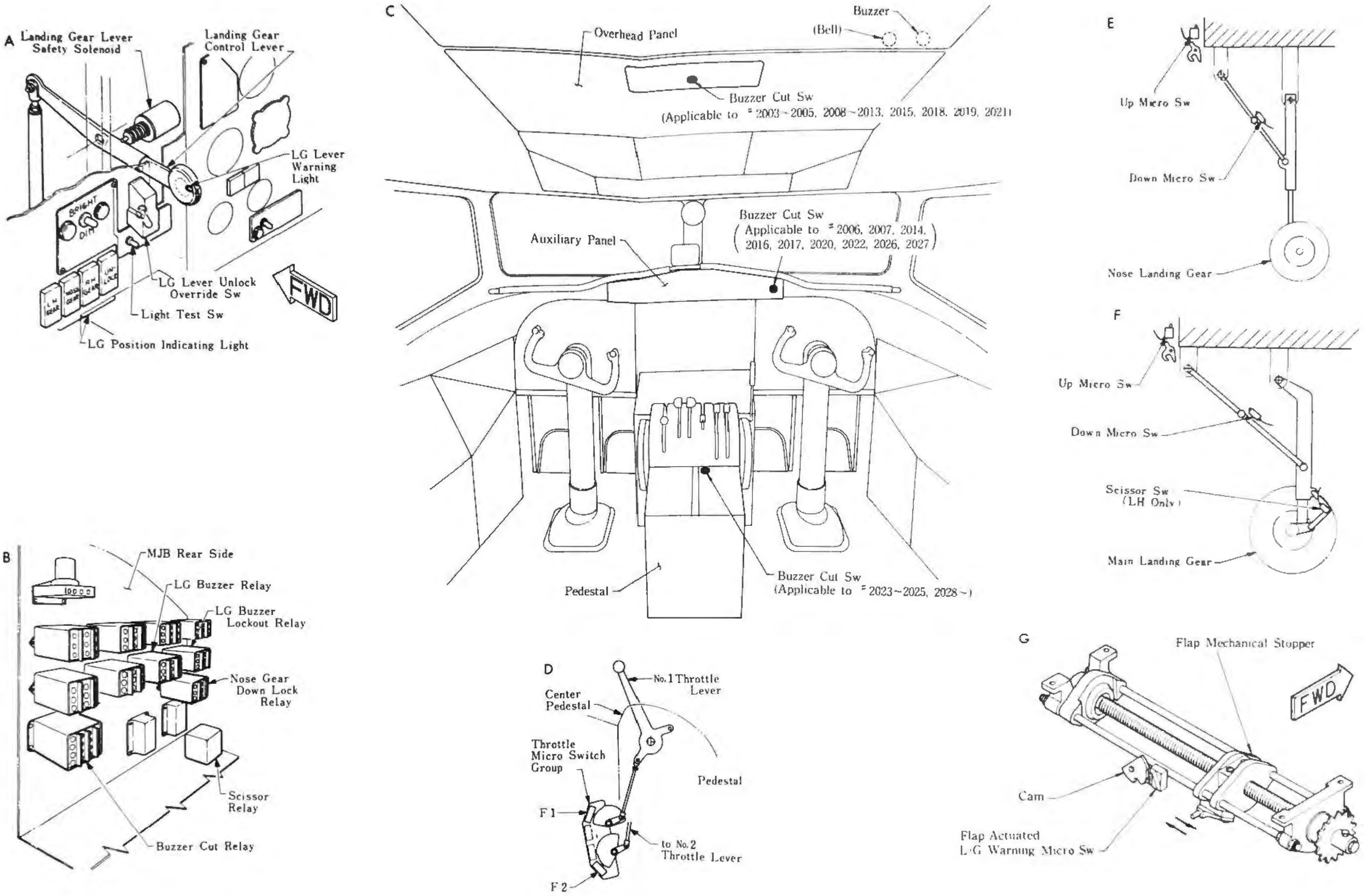
(2) Warning System

A. When one of three gears is not locked at the DOWN LOCK position, if the throttle lever is pulled back beyond the flight idle position, the red lamp on the head of the landing gear lever comes on and also the buzzer on the cockpit ceiling sounds. (the buzzer can be stopped).

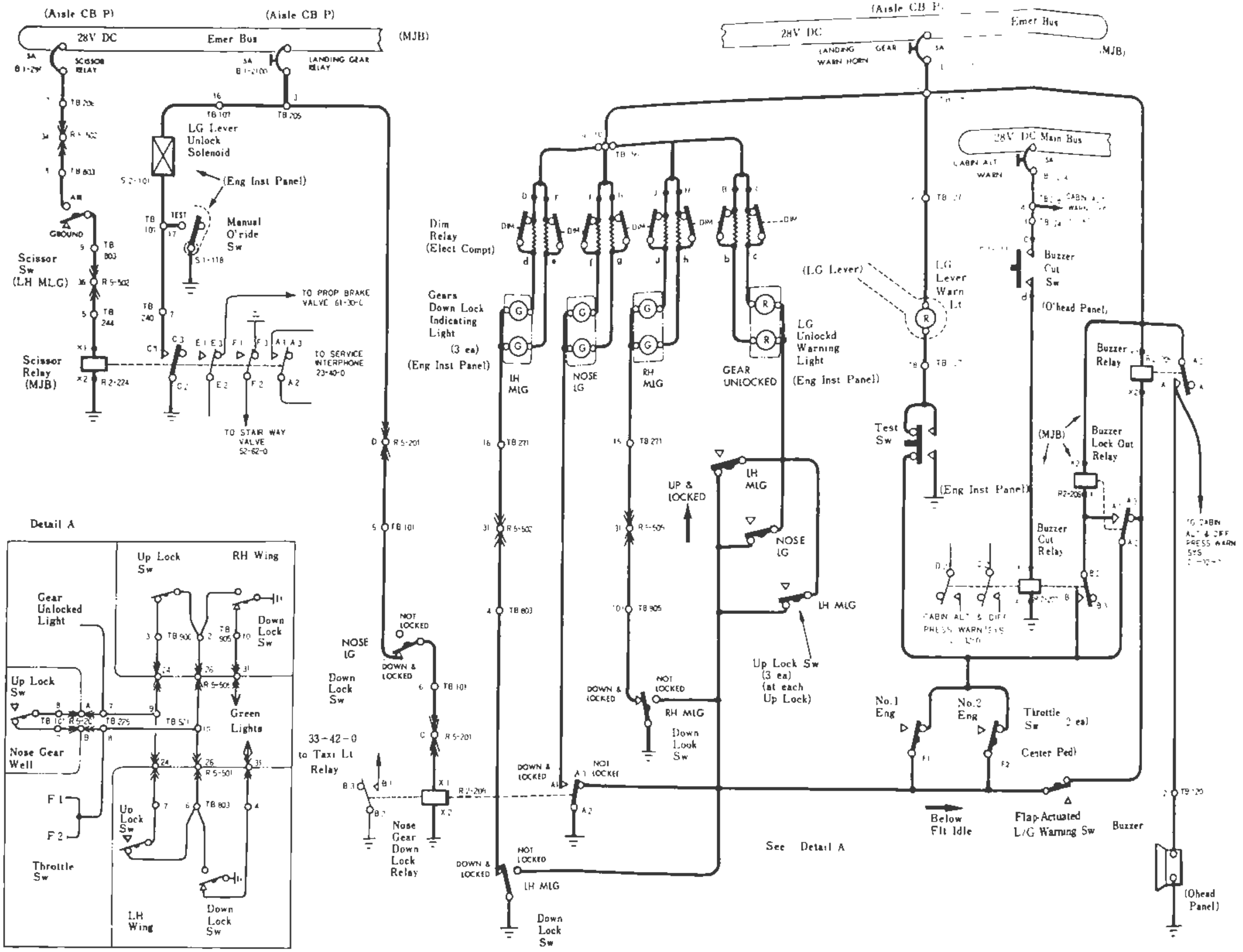
B. Like A above, with one of three gears not down-locked, if the flap is lowered more than 22.5 degrees, the said red lamp comes on and the buzzer sounds. (buzzer can not be stopped)

(3) Landing Gear Control Lever Safety Device

The landing gear control lever is designed to be held by the safety solenoid pin which prevents the lever from being raised beyond the neutral position when the aircraft is on the ground.
When the left main gear becomes clear off the ground and is fully extended, the scissor switch is switched to FLT ON and the solenoid pin is electrically drawn back, moving up the lever can.

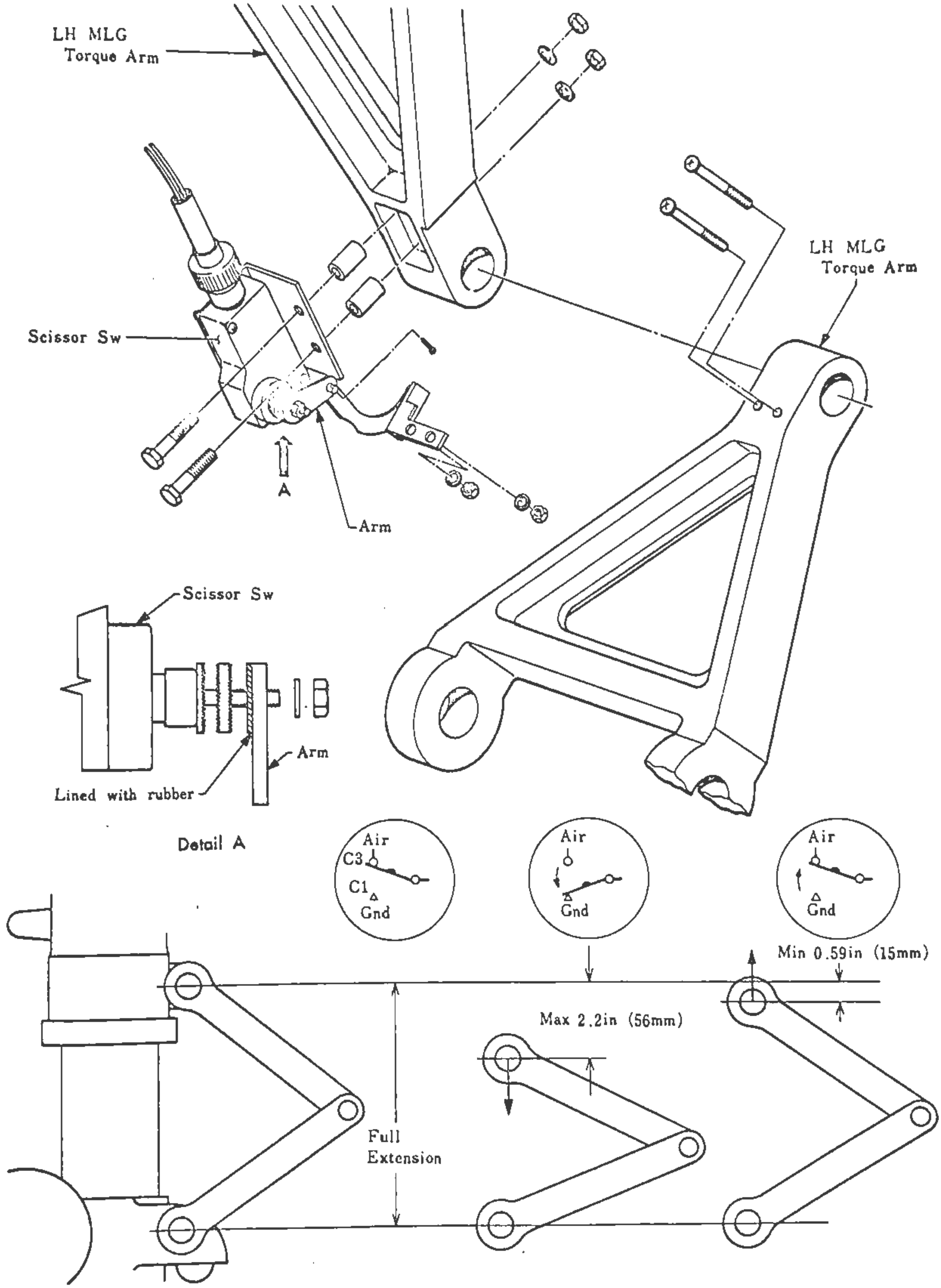


Landing Gear Electric & Warning System
Figure 3-47



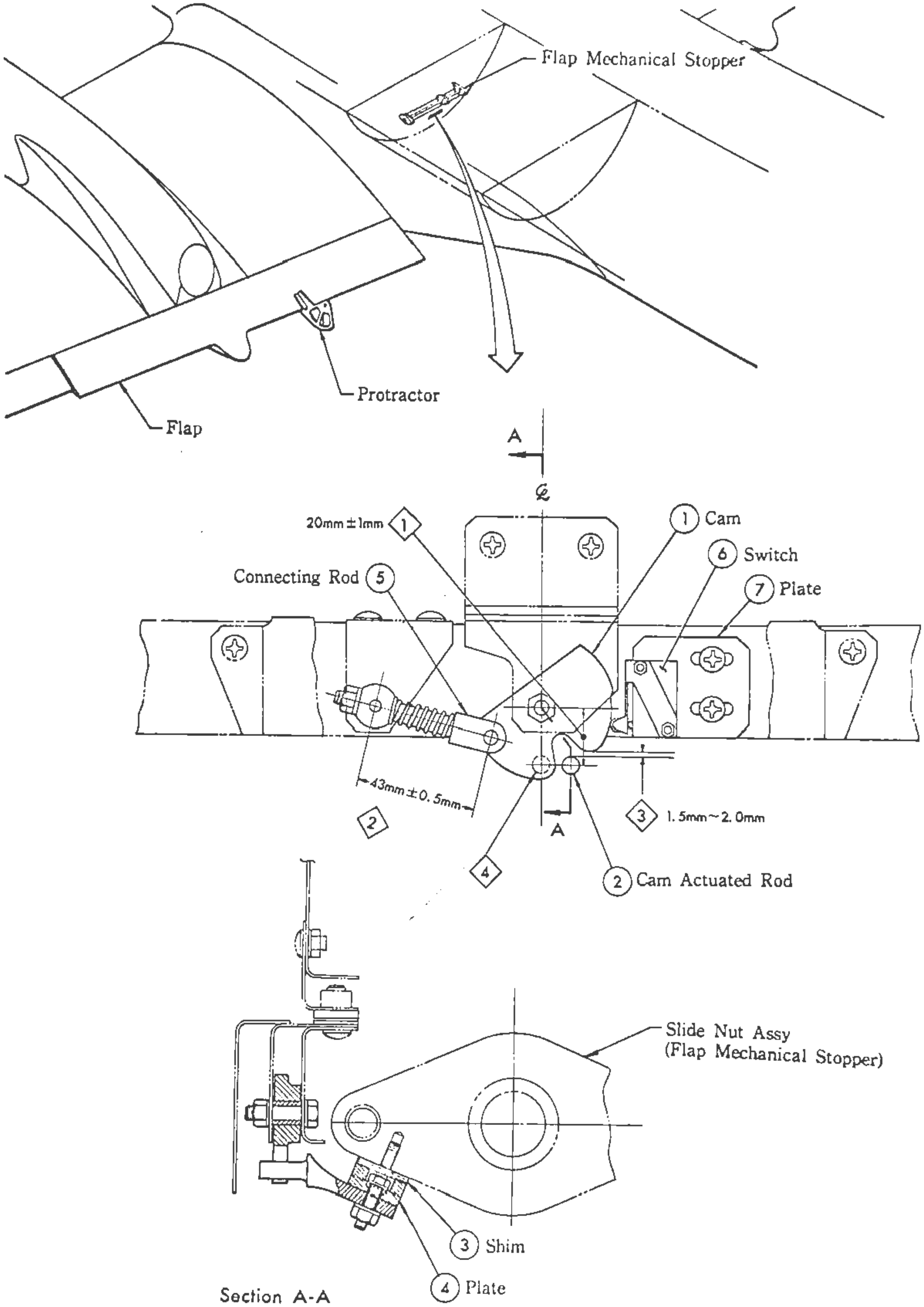
Landing Gear Indicating & Warning Electric System Schematic

Figure 3-48



Scissor Switch (LH MLG Only)

Figure 3-48A



Adjustment Flap Actuating Landing Gear Warning Micro Switch

Figure 3-48B

3.7.2 Main Gear Down Lock Visual Check System

When the electrical landing gear position indication system does not work, the down-locked main gear can be ascertained by visual inspection, through the window at the rear cabin, and the gear position indicator at the lower end of the drag link.

When the gear is locked at the DOWN LOCK position, red fluorescent paint with stripes on the inner cylinder becomes visible through the opening of the outer cylinder. For easier confirmation, a lamp is provided above the indicator.

3.7.3 Nose Gear Down Lock Visual Check System

Open the peep hole on the floor under the center pedestal in the cockpit and the nose gear down-lock can be seen in the mirror through the window on the front wall of the electrical compartment.

The nose gear down-lock mechanism is coated with red fluorescent paint. When the nose gear is locked at the DOWN LOCK position, the red fluorescent coating appears continuous. As this area is dark, a lamp is installed to illuminate the down-lock mechanism.

3.7.4 Adjustment (Fig. 3-48B)

Accomplish this adjustment after the flap and the mechanical stopper have been adjusted.

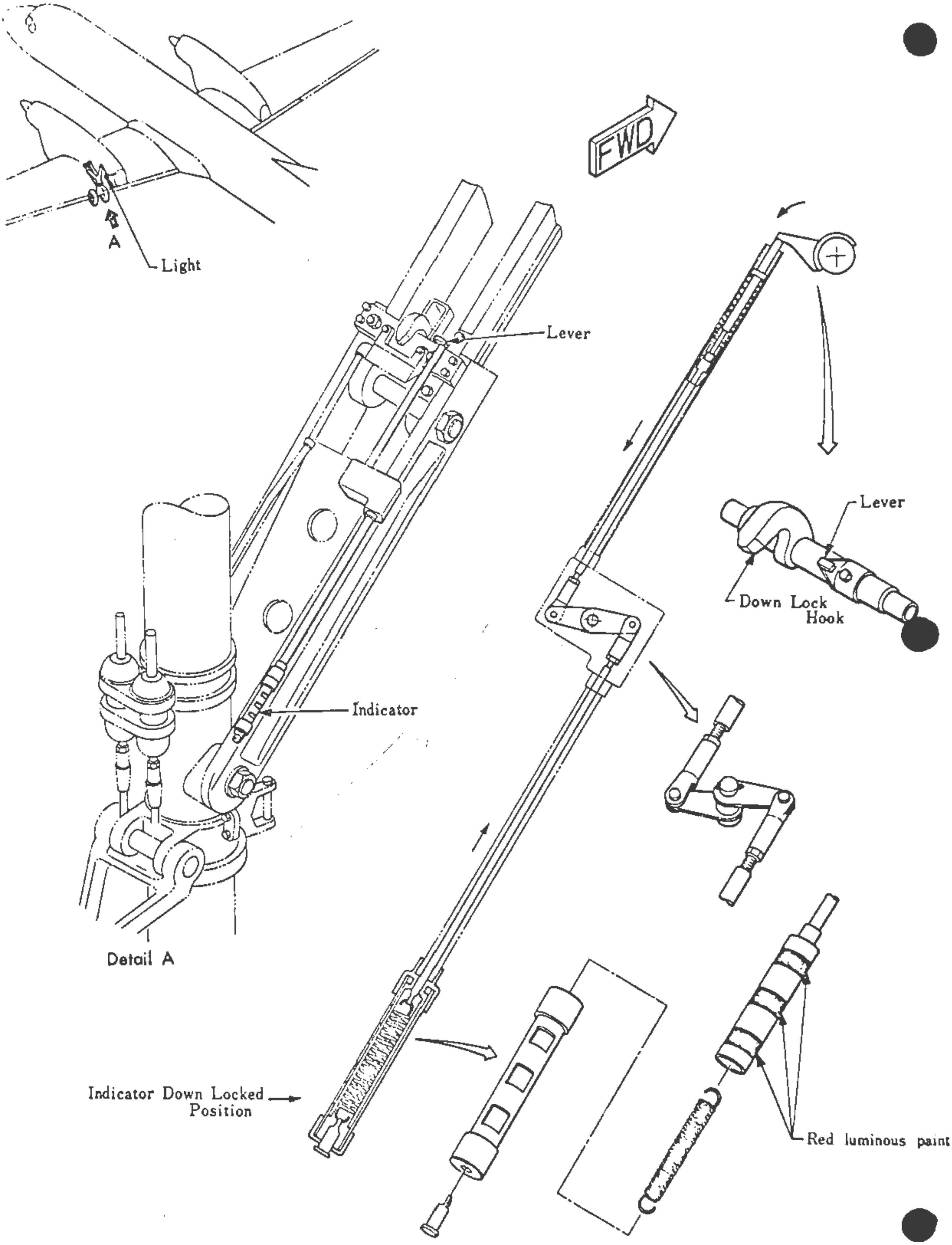
(1) Adjust shims (3) so that the distance ◇1 between the center of rotation of the cam (1) and the center of the cam actuated rod (2) is 20±1mm and install the plate (4).

(2) Install the connecting rod (5) so that the dimension ◇2 is 43±0.5mm. Make sure that the clearance ◇3 is 1.5 to 2.0mm.

(3) With the flap down, measure the flap angle with a protractor and stop it at 22.5°±1°.

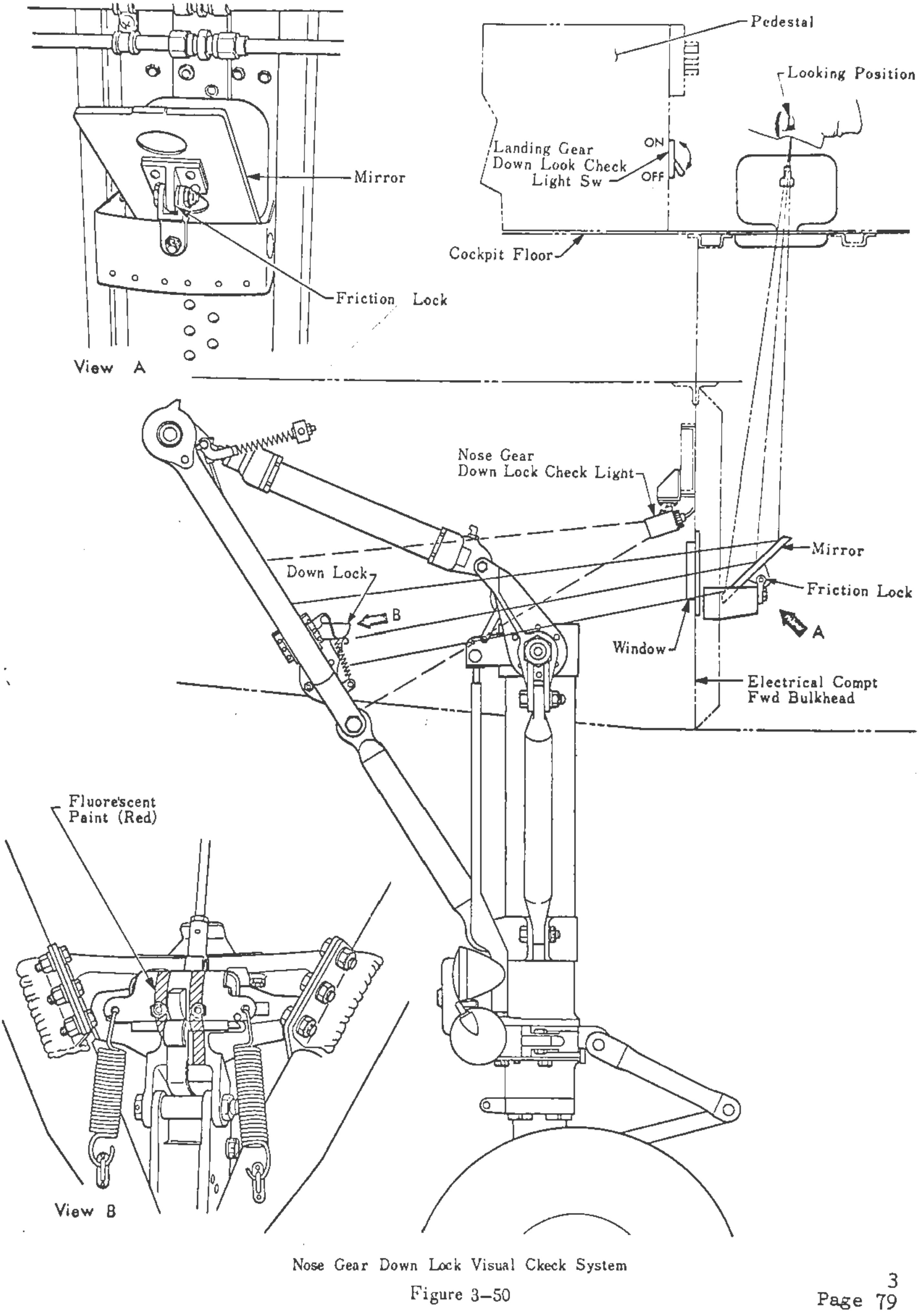
(4) Adjust the serration of the cam actuated rod (2) so that the cam actuated rod (2) rests on the center line ◇4 of the cam (1) under the conditions described in para. (3) and install it.

(5) Adjust the attachment of the plate (7) so that the switch (6) slides smoothly along the contour of the cam and it is actuated roughly at the center of the cam slope.



Main Landing Gear Down Lock Visual Check System

Figure 3–49



Nose Gear Down Lock Visual Ckeck System

Figure 3–50

Chapter 4 POWER PLANT

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4.1 General

The Rolls Royce Dart MK542-10 turboprop engines are installed on the aircraft as complete power units.

This power unit consisting of the engine, propeller, engine mount, piping and wiring is a replacement unit which can be installed in any nacelle.

The propeller can be handled as a replacement unit and the power unit without the propeller is also a replacement unit, while the propellers are also interchangeable.

The engine is mounted on the engine mount at its three forward points while the mount is attached to the nacelle subframe at its four rear points.

Around the engine mounted on the nacelle are installed the cowling, fairing and panels on which are provided the inlet and outlet ports for cooling of the engine and gear box, and accessories mounted on them.

The engine is a gas turbine engine with a 2 stage centrifugal compressor and 3 stage turbine. The engine controlled by the throttle in the cockpit through cables and control rods, drives the propeller, while the exhaust gas at high temperatures from the turbine section flows through the exhaust pipe over the upper surface of the wing and is ejected outboard from the end of the nacelle, developing a little thrust.

The accessories are installed in the upper part of the nacelle. The engine shaft drives the DC generator, AC alternator, hydraulic pump, supercharger etc. through gears and drive shafts at reduced speeds.

Engine Data

Power:	(at I.S.A., Sea Level, Static Condition) RPM	SHP	Thrust	TEHP
Take-off (with W/M)	15,000	2,775	740 lb (336 Kg)	3,060
Take-off (without W/M)	15,000	2,400	660 lb (299 Kg)	2,655
Max. Continuous	15,000	2,400	660 lb (299 Kg)	2,655
Max. Cruise	14,200	1,880	525 lb (238 Kg)	2,080

NOTE: In calculating SHP, 70 HP required to drive the gear box has been taken into account.

$$\text{TEHP} = \text{SHP} + \frac{\text{Thrust (lb)}}{2.6}$$

Dimensions:

Diameter	Max. (bulkhead) approximately 38 in.
Length	99.5 in.
Weight (dry)	Max. 1,377 lb.

Direction of Rotation:

Propeller	Counter clockwise viewed from the rear.
Engine	Clockwise viewed from the rear.

Propeller:	4 blade, variable pitch Diameter 14.6 ft.
Reduction Ratio:	0.0775 : 1
Compressor:	2 stage, centrifugal Pressure ratio 6.25 : 1 Mass air flow 26.5 lb/sec (I.S.A., 15,000 rpm)
Combustion Chambers:	7 interconnected chambers Ignitors are provided in No. 3 and No. 7.

4.2 Engine

4.2.1 Summary

The engine is a turboprop engine which drives the propeller and the 2 stage compressor with the 3 stage turbine.

This engine consists of the 2 stage centrifugal compressor, 7 combustion chambers and 3 stage axial turbine. The compressor is driven by an outer shaft connected directly to the turbine and the propeller is driven by an inner shaft provided in the outer shaft and connected directly to the turbine, through the reduction gears.

Air taken in from the engine front enters the first stage compressor, pressurized here and, then, enters the second stage compressor, pressurized here again.

Air leaving the compressor enters the combustion chambers in which fuel is injected to burn. The air becomes a suddenly expanded gas flow and passes the turbine.

The most part of the energy contained in this expanded gas is absorbed by the turbine which drives the compressor and the propeller through the reduction gears, generating the propeller thrust. The energy not absorbed by the turbine passes the jet pipe and is ejected rearwards, developing a little amount of available thrust. Water/methanol can be injected to augment the engine power.

4.2.2 Major Components

The engine consists of the following major components:

(1) Air Intake Casing Section

  - Air Intake Cowling
  - Air Intake Casing
  - Reduction Gear
  - Oil Tank
  - Bevel Gear Assembly

(2) Compressor Section

  A. Front Casing

    - Rotating Guide Vane
    - Compressor (Impeller)
    - Diffuser

  B. Main Casing (Interstage Casing)

    - Inner Casing
    - Interstage Guide Vanes

  C. Outlet Casing

    - Rotating Guide Vanes
    - Compressor (Impeller)
    - Diffuser

(3) Combustion Section

  A. Combustion Chamber

    - Burner

  B. Intermediate Casing

(4) Turbine Section

  - Nozzle Box
  - Nozzle Guide Vanes
  - Turbine Assy
  - Bearing Housing
  - Heat Shield

(5) Exhaust Section

  - Exhaust Unit
  - Jet Pipe Assy
  - Jet Pipe Shroud

(1) The air intake casing is made of magnesium casting.

On the front of the casing is attached the nose cowling with the electrical deicer system and on the rear side of the cowling is installed a flange which fits the nacelle cowling.

On the L.H. side of the casing are installed the oil filter, water/methanol unit and fuel pump. On the R.H. side are installed the propeller control unit (P.C.U.), feathering pump and starter motor. On the top is located the oil cooler, while on the lower side are installed the engine oil system accessories.

In the casing are located the reduction gear for driving the propeller, oil pump and oil tank.

(2) The compressor front casing is made of magnesium casting.

The main casing (interstage casing) is made of AL ALLOY. The 2 stage centrifugal compressor is retained in this casing. 3 engine mounting fittings are provided on the main casing.

On the lower side is installed the hot air gate valve. On the L.H. lower part and the R.H. upper part are installed the fuel flow control unit (F.C.U.) and the oil pressure transmitter, respectively.

On the outlet casing are installed the breather outlet, accessory drive adapter and compressed air spill outlet. The engine fire wall is also fixed to this casing. The compressed air enters 7 combustion chambers from the compressor outlet casing.

(3) Around the intermediate casing are arranged the combustion chambers which are connected to the turbine nozzle box.

In each combustion chamber are provided a flame tube and burner. The burner injects fuel into the tube, mixing it with air for combustion.

The high energy ignition plugs are provided in No. 3 and No. 7 combustion chambers only to be used for starting. The flame is propagated to the remaining chambers through the interconnectors.

(4) Air burnt and heated in the combustion chambers enters the turbine in the nozzle box.

The turbine wheel consists of discs made of chrome-molibdenum steel and blades.

This 3 stage turbine absorbs the most of the energy contained in the gas flow and converts it into torque to drive the compressor, propeller and accessories.

The gas temperature (turbine gas temperature, T.G.T.) at the turbine exposed high temperatures and pressures is an important parameter for engine control and the temperature is measured by thermo couples located on the second stage nozzle guide vanes (between the first and the second stage turbine wheels).

(5) The gas leaving the turbine is sent to the jet pipe smoothly by means of the exhaust unit provided in the engine nozzle box, reducing the back pressure acting on the turbine.

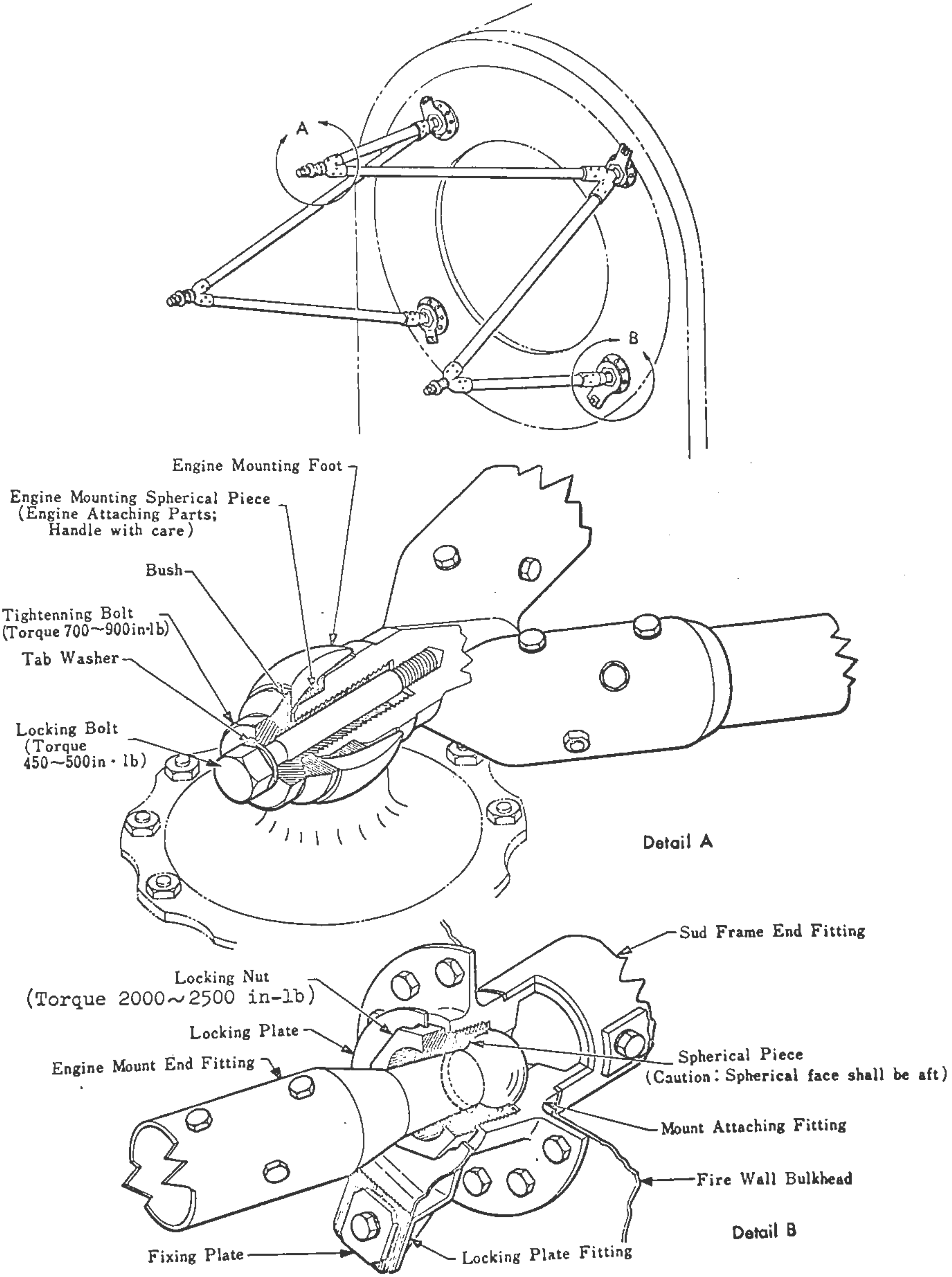
4.3 Engine Mount (Fig. 4-1)

The engine mount is of steel pipe frame construction and its end fittings are all made of forged steel. 3 V shape steel pipe structures are joined together with end fittings and 3 forward points are supported by fittings which are attached on the compressor casing.

The engine mounting feet and engine mounting spherical pieces are joined together at the engine mount end fittings and tightened with hollow tightening bolts screwed in through bushes. A locking bolt with L.H. screw is inserted into the hollow, tightened and locked with a tab washer.

The mount attaching fitting attached to the engine mount rear support B is fixed to the sub-frame and the fire wall with shear bolts.

The 4 engine mount rear supports are fixed to the mount attaching fittings with locking nuts through spherical pieces, that is, ball end halves of the engine mount end fittings. The locking nuts are fixed by the lock plates.


A
B
Engine Mounting Foot
Engine Mounting Spherical Piece (Engine Attaching Parts; Handle with care)
Bush
Tightenning Bolt (Torque 700~900in·lb)
Tab Washer
Locking Bolt (Torque 450~500in · lb)
Detail A
Sud Frame End Fitting
Locking Nut (Torque 2000~2500 in-lb)
Locking Plate
Engine Mount End Fitting
Spherical Piece (Caution: Spherical face shall be aft)
Mount Attaching Fitting
Fire Wall Bulkhead
Detail B
Fixing Plate
Locking Plate Fitting

Engine Mounting

Figure 4–1

4.4 Cowling and Fairing

4.4.1 Summary

The nacelle in front of the fire wall is faired with the cowling and the fairing provided in the forward lower part of the fire wall.

When the cowling and the fairing are closed, the overlapping part serves as sealing. The fairing is usually kept installed but it can be removed if necessary. The cowling opens rearwards like flower petals.

NOTE: For the gear box top cover in the rear of the fire wall, exhaust pipe upper cover and gear box side cover, see Chapter 2.

4.4.2 Cowling (See Fig. 4-2, 3, 4, 5 and 6)

The engine cowling consists of 4 panels. The L.H. and R.H. side panels are attached to the L.H. and R.H. nacelle hinges, respectively, the top panel is joined to the L.H. side panel and the bottom panel to the R.H. side panel, through respective hinges.

The cowling made of light alloy, is of double skin construction with partial single skin. The forward ends of the cowling panels are fixed to the engine air intake cowling with screw type fasteners. The top and bottom panels are fastened with latch hooks. The fairing and the side panels are fastened with latch hooks at one location on the L.H. and R.H. sides, respectively.

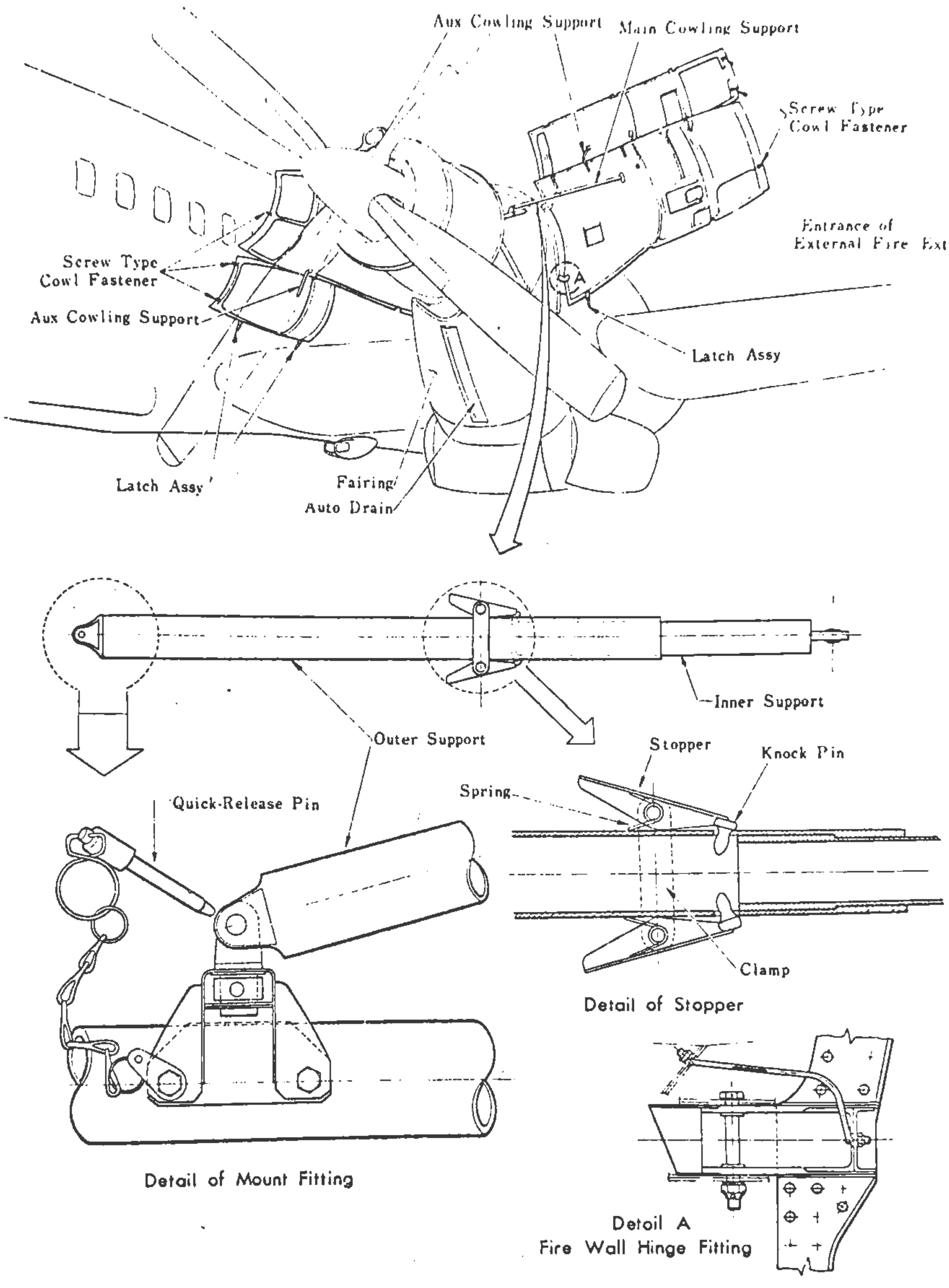
When the cowling is opened, the cowling panels are locked with main cowling supports, 1 ea. The top and bottom panels are locked to the side panels with auxiliary cowling supports, 1 ea.

On each cowling panel is provided a fire wall to separate the compressor section from the hot section when the cowling is closed.

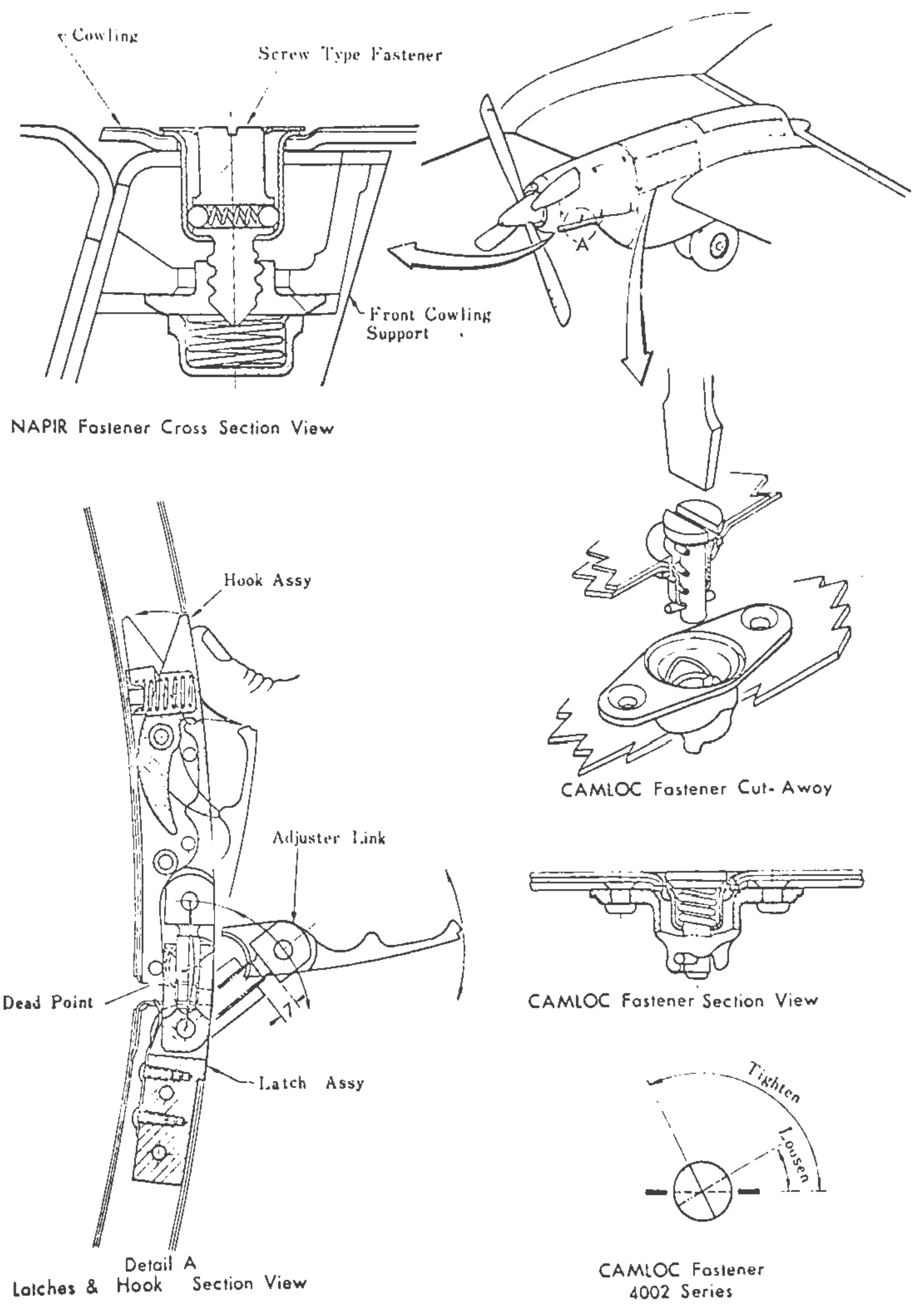
On the L.H. side panel are provided the oil filter cap access panel and fuel filter access panel which are all fastened with hinge latches. On the L.H. side panel are provided fire access doors for Zone I and Zone II through which the hoses of the fire extinguishers on the ground can be inserted for extinguishing fire. As the doors are closed by spring force only, they can be opened by pushing in the hose nozzles. The fire access door for Zone I is provided on the pressure relief door. The pressure relief door is provided on the L.H. side panel. This door relieves the pressure in a space between the engine and the cowling to prevent the high pressure due to the engine casing failure from damaging the aircraft.

The door is fastened to the hinge at its forward part and the rear part is fastened with rivets.

As the inner pressure rises, the rivets are shorn, opening the door outwards. As the pressure decreases, the propeller slip stream closes the door automatically.



Engine Cowling (Showing Full Open)
Figure 4-3



NAPIR Fastener Cross Section View

CAMLOC Fastener Cut-Away

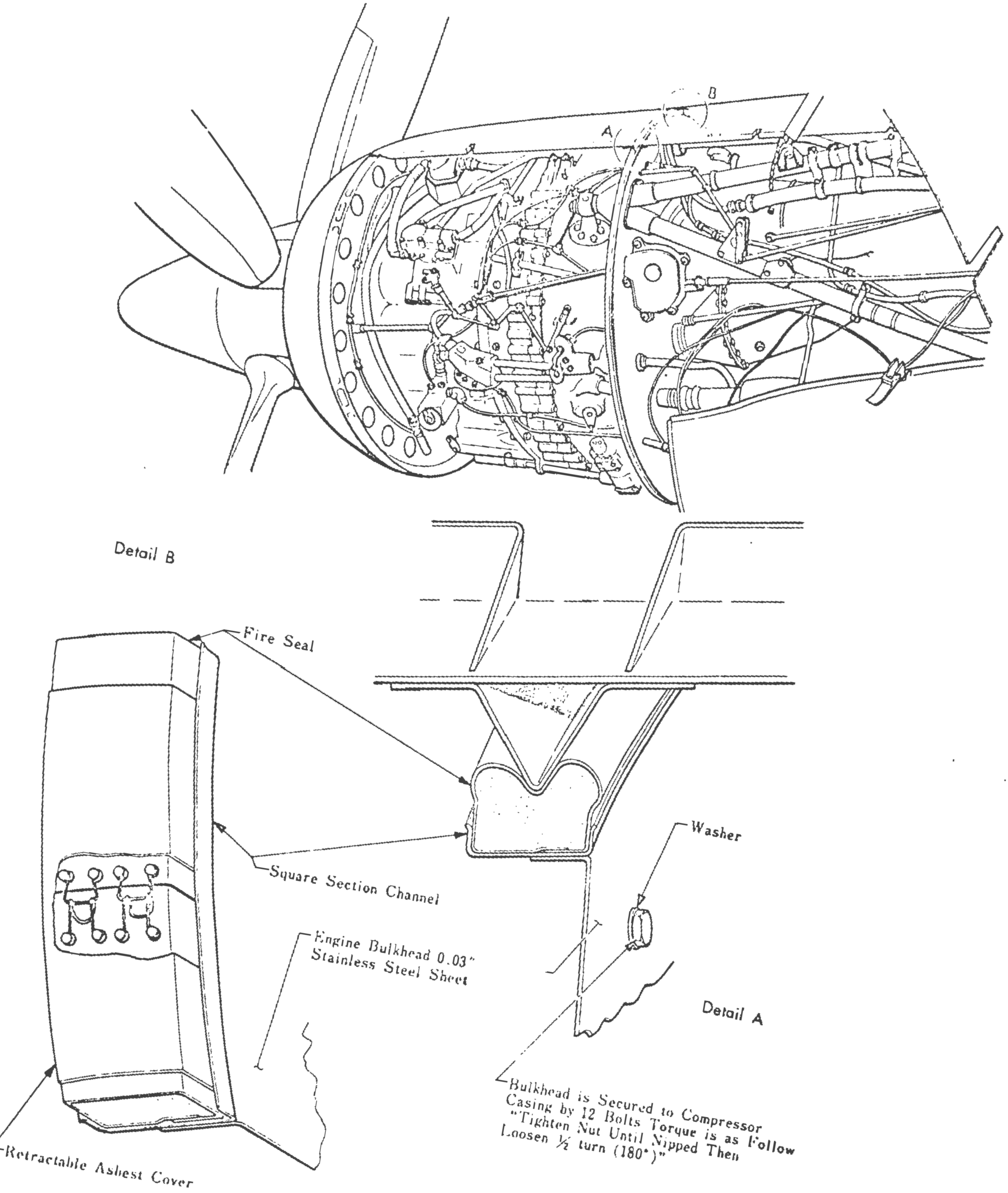
CAMLOC Fastener Section View

Detail A
Latches & Hook Section View

CAMLOC Fastener
4002 Series

Latches & Fasteners

Figure 4-5



Bulkhead is Secured to Compressor Casing by 12 Bolts Torque is as Follow "Tighten Nut Until Nipped Then Loosen ½ turn (180°)"

Engine Fire Seal
Figure 4–6

4.4.3 Fairing (See Fig. 4-2, 3, 4, 5 and 6)

The fairing in the forward bottom section of the fire wall is of single skin construction made of light alloy, being fixed to the fire wall with bolts. This fairing can be removed if necessary.

On the L.H. and R.H. sides of the upper part of the fairing are provided latches with which the fairing can be fixed to the cowling side panels securely.

The latches are of the same kind as that used on the cowling. Inside the fairing are provided the outlet duct for the engine turbine cooling air and the hot air duct for the fuel heater.

4.5 Accessory Drive Gear Box

4.5.1 Summary (See Fig. 4-7)

The accessory drive gear boxes are installed between the airframe fire wall and the wing spar in the upper part of the L.H. and R.H. nacelles, respectively.

Between the engine and the gear box is provided a drive shaft which transmits engine power to the gear box.

The gear box is bolted to the sub-frame in the nacelle with brackets at the front end of the drive shaft and at both ends of the main casing.

At the front end supporting point, a support assembly with a ferobestos bush at the front end of the drive shaft housing is attached to the airframe fire wall with 4 bolts.

The L.H. side bracket of the main casing is attached to the sub-frame fitting through a lifting fitting, taking into account thermal expansion and manufacturing tolerances. In the bolt holes of the bracket are used the spherical bearings.

Around the gear box is provided a bulkhead which collects leaked or drain oil.

Around the unit are arranged the fire detectors. The gear box becomes accessible by opening the hinged top cover. On this cover is also provided an access cover through which the oil level can be checked with a dip stick.

4.5.2 Gear Box

L.H. installation

Type (C) P.T.G. 14/22 (with propeller brake, L.H. engine)

R.H. installation

Type (C) P.T.G. 14/23 (without propeller brake, R.H. engine)

4.5.3 Gear Box Drive (See Fig. 4-9 and 10)

The engine power is transmitted from the impeller shaft gear installed on the 2 stage compressor drive shaft (H.P. impeller shaft) to the gear box drive through 4 gears in the outlet casing and, then, to the gear box tunnel shaft through the universal joint, driving accessories through the reduction gears. The gear box shaft is provided with a quill shaft which fails when the gear box drive shaft is subjected to an overload.

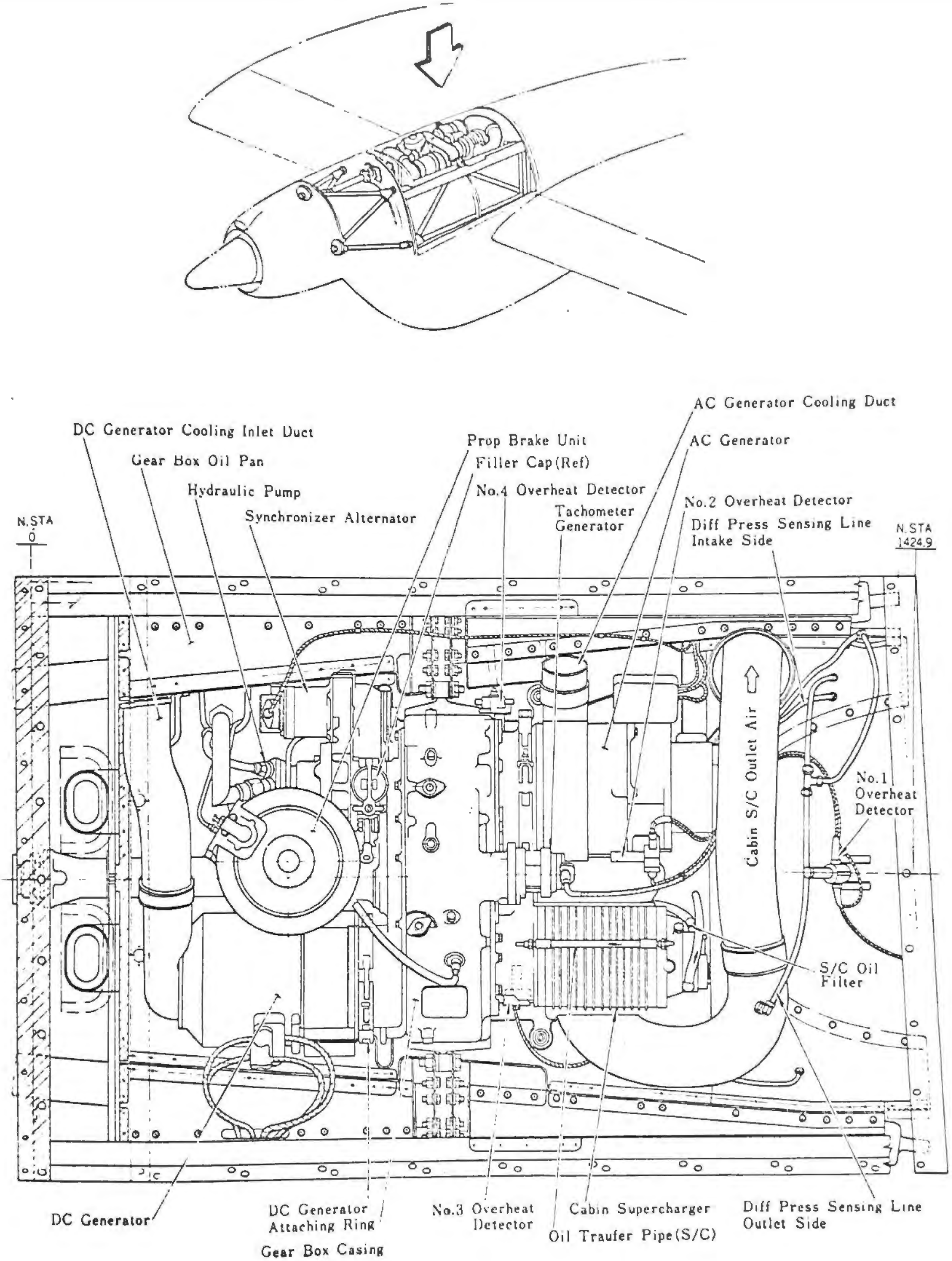
The quill shaft failing torque

Max. Safety Torque	11,600 lb.in
Gear Box Input Gear Ratio	0.3448

4.5.4 Gear Box Accessory Attachment (See Fig. 4-7 and 8)

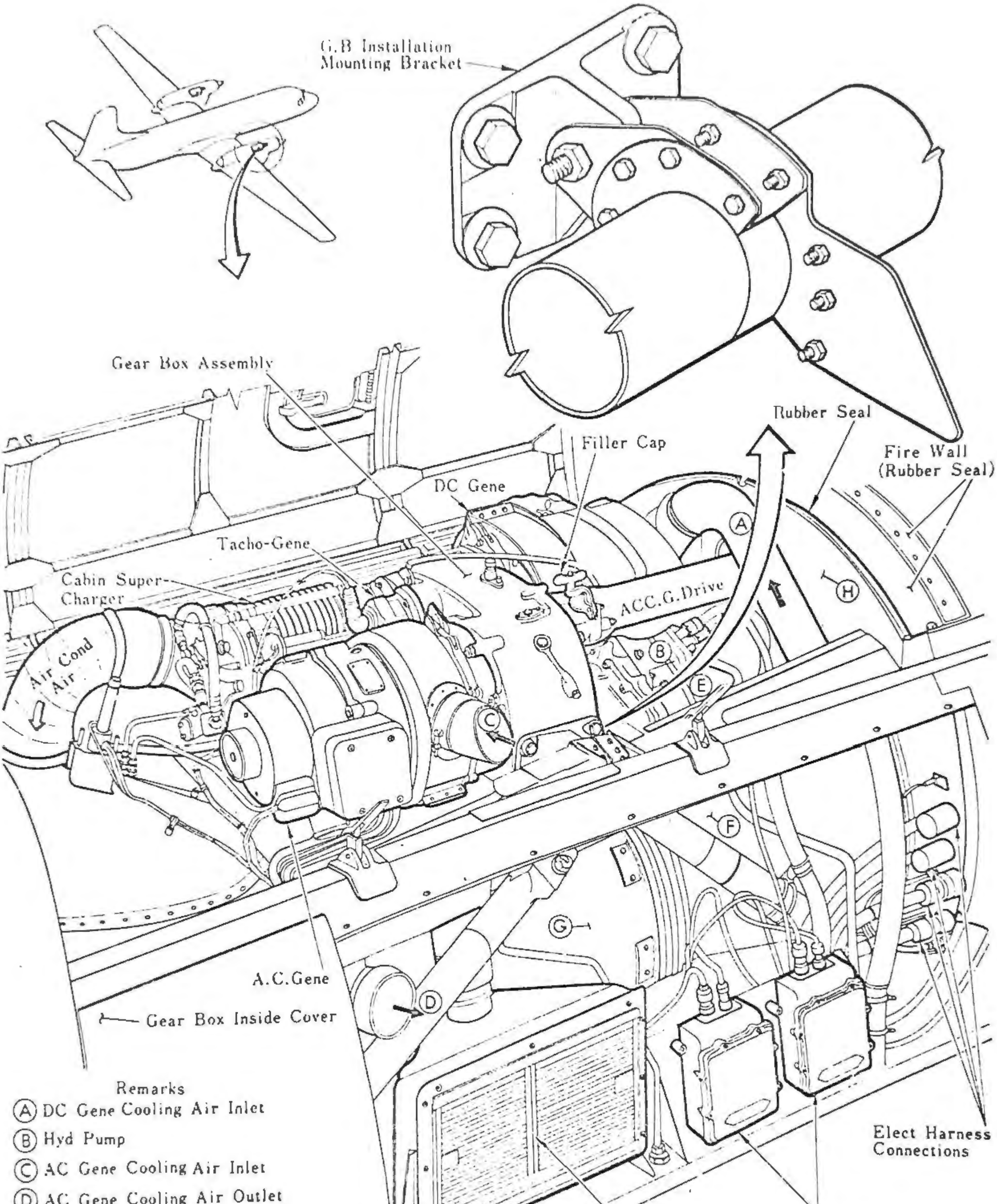
		Reduction Ratio (against gear box input)
Alternator	Rotax, 30kV	1.758
Tachometer Generator	Smiths	0.725
Cabin Supercharger	Godfrey	2.333
D.C. Generator	Jack & Heintz 12KW	1.490
Hydraulic Pump	Vickers	0.77
Synchronizer Alternator	Dowty Rotol	1.077
Propeller Brake	Dunlop	1.071

NOTE: For details of the gear box, see Dowty Rotol, Maintenance Manual 922A.



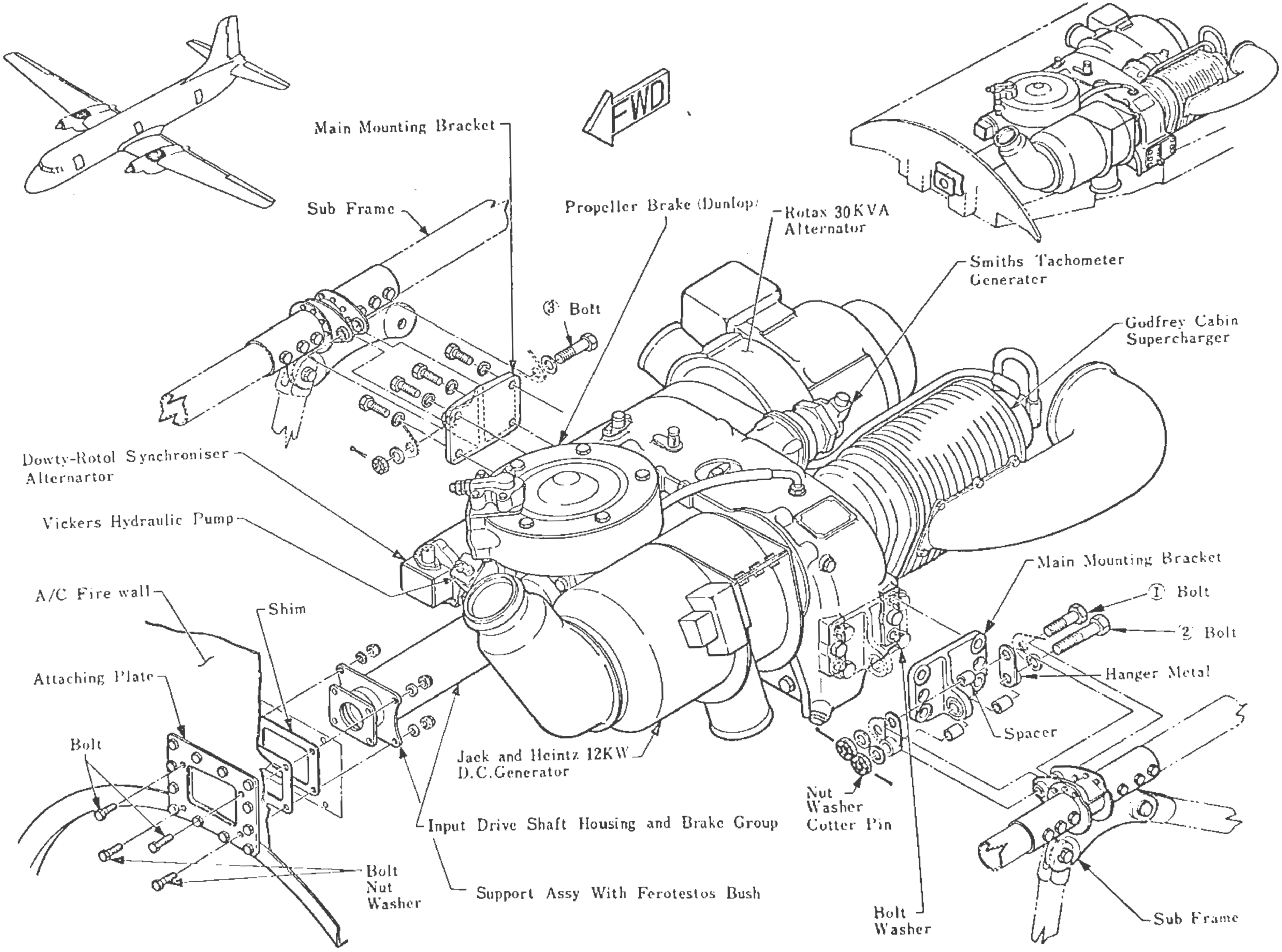
Installation of Accessory Gear Box

Figure 4–7

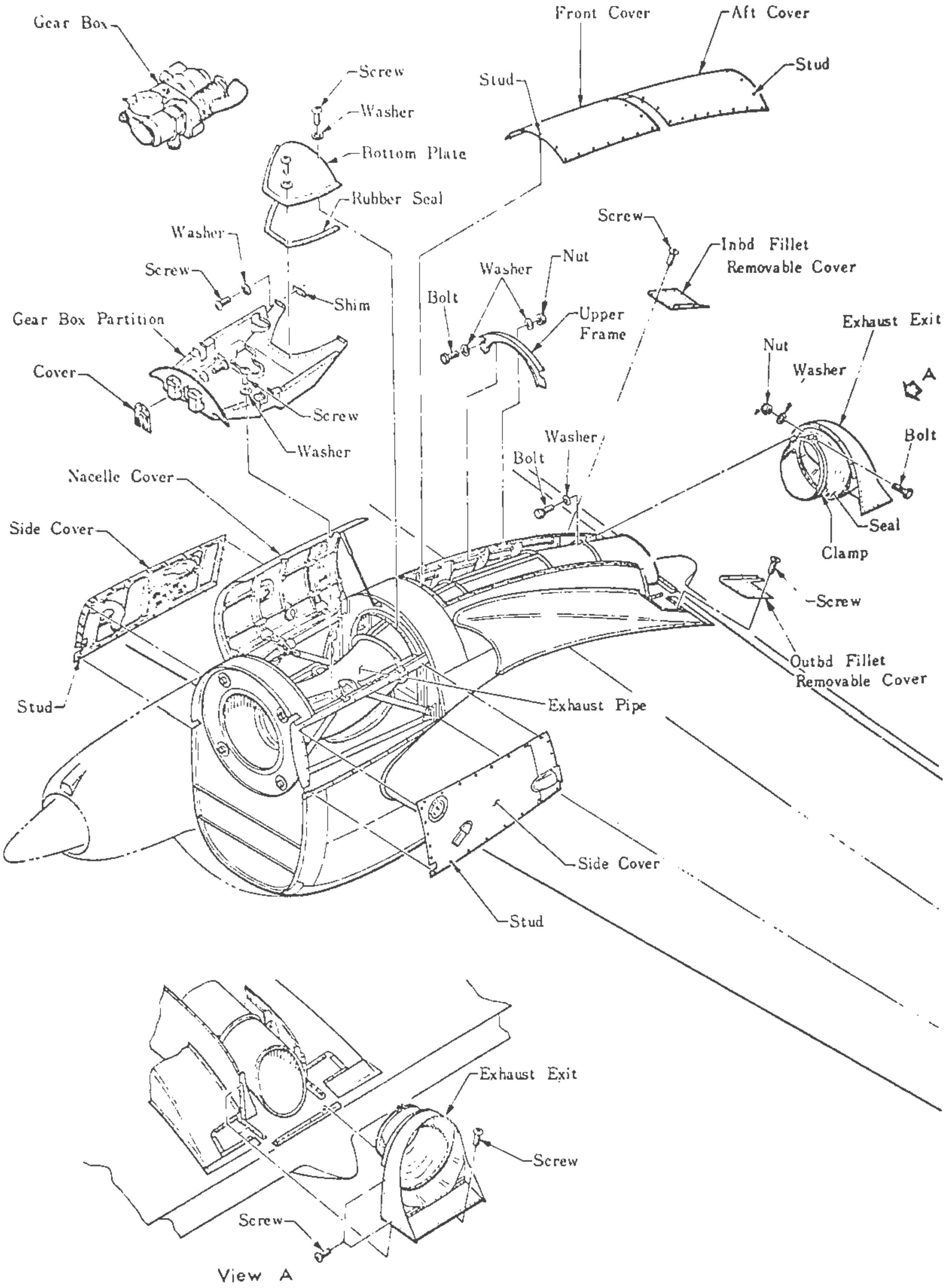


Side View of Accessory Gear Box Installation (RH)

Figure 1–8

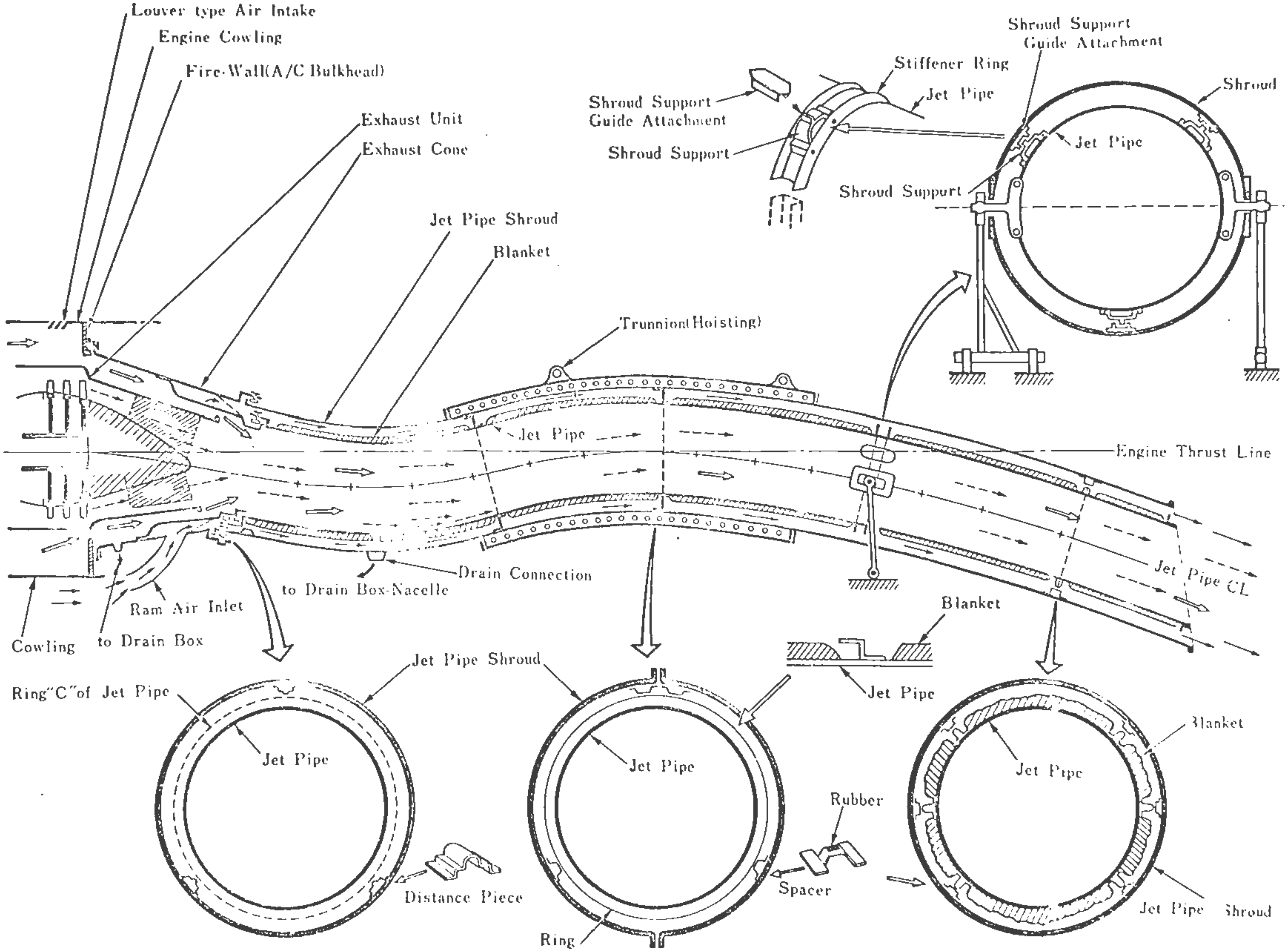


Installation of Accessory Gear Box
Figure 4–9



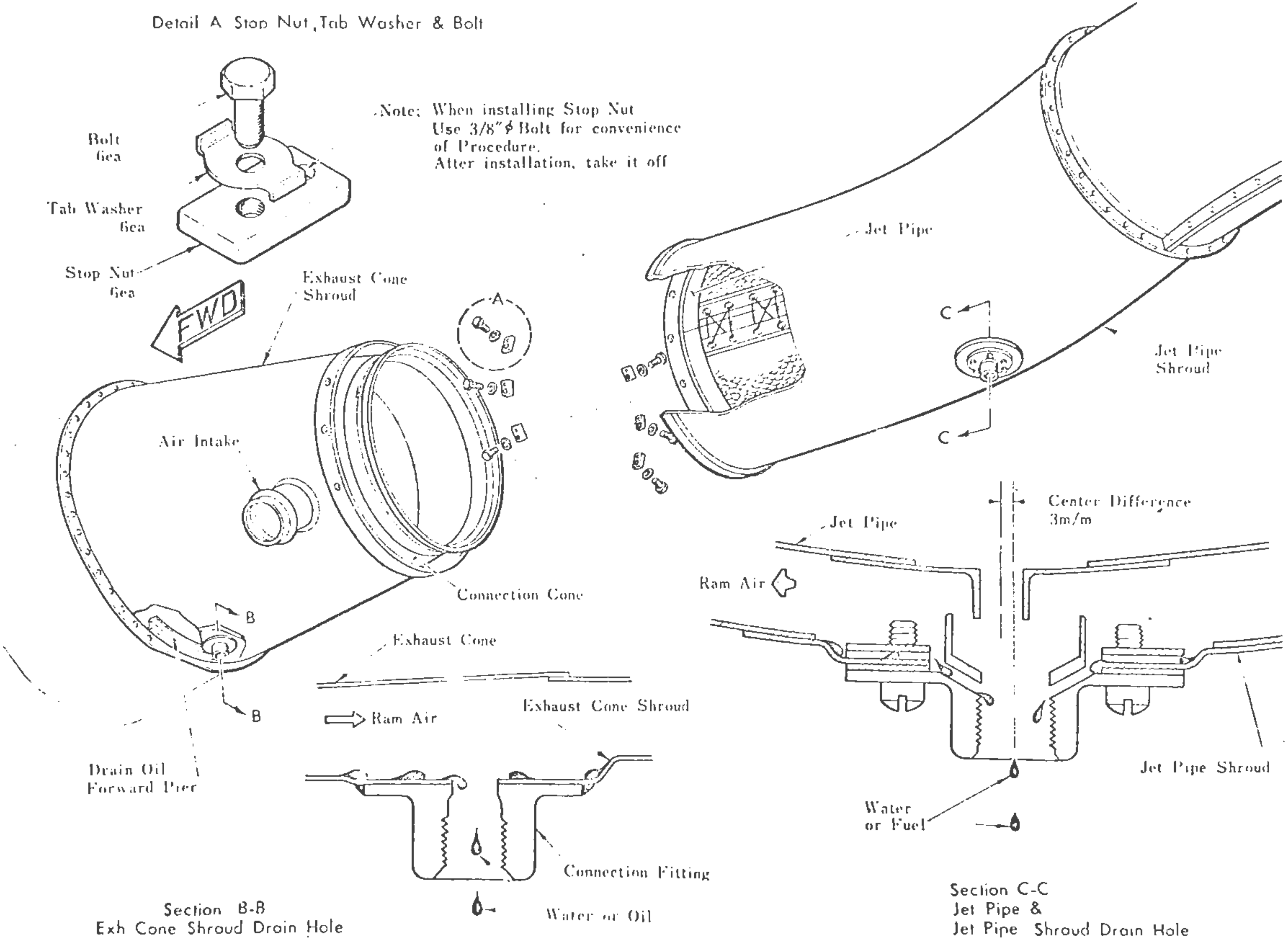
Exhaust Pipe Shroud Assy Remove Installation

Figure 4–12



Exhaust System Functional Schematic

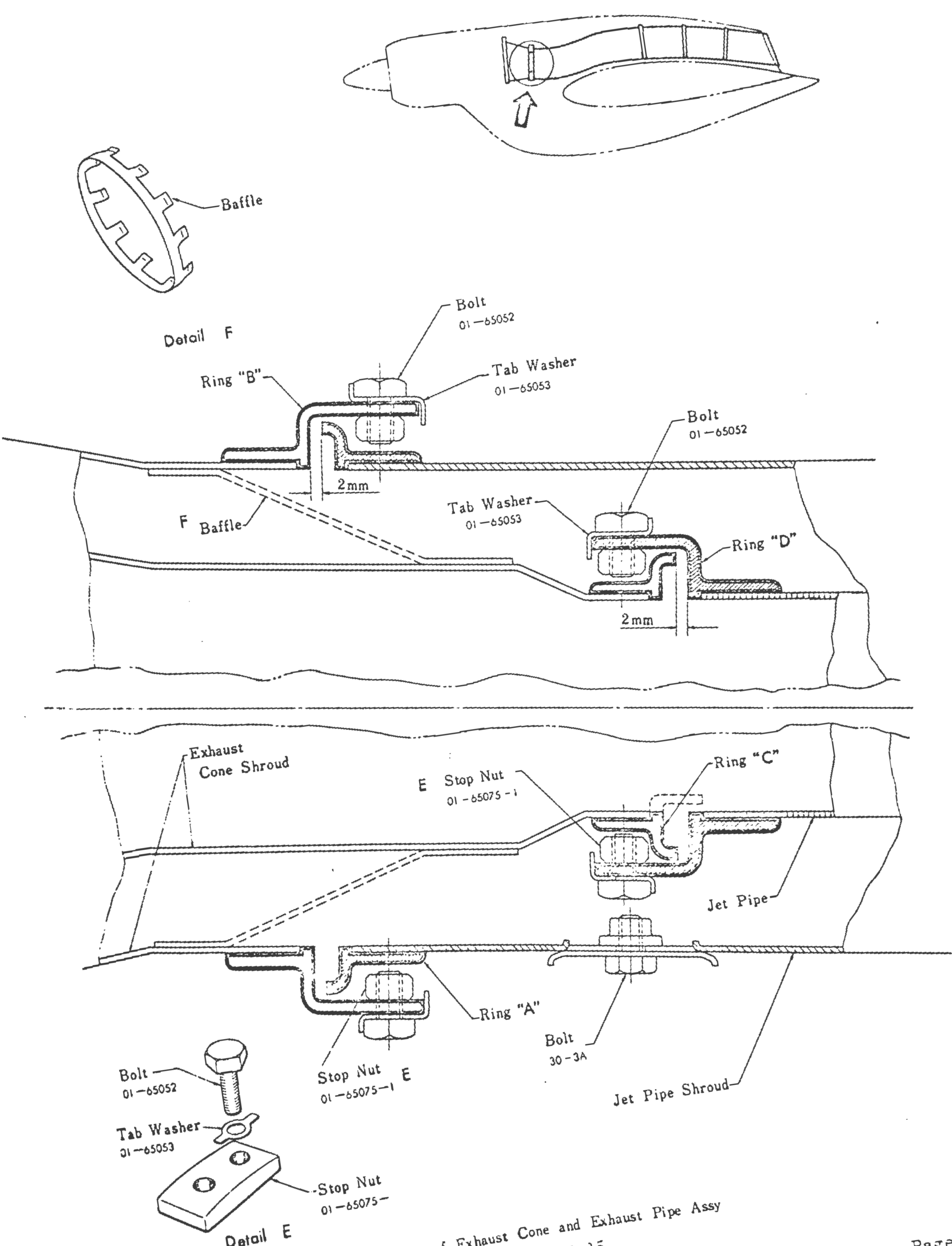
Figure 4-13



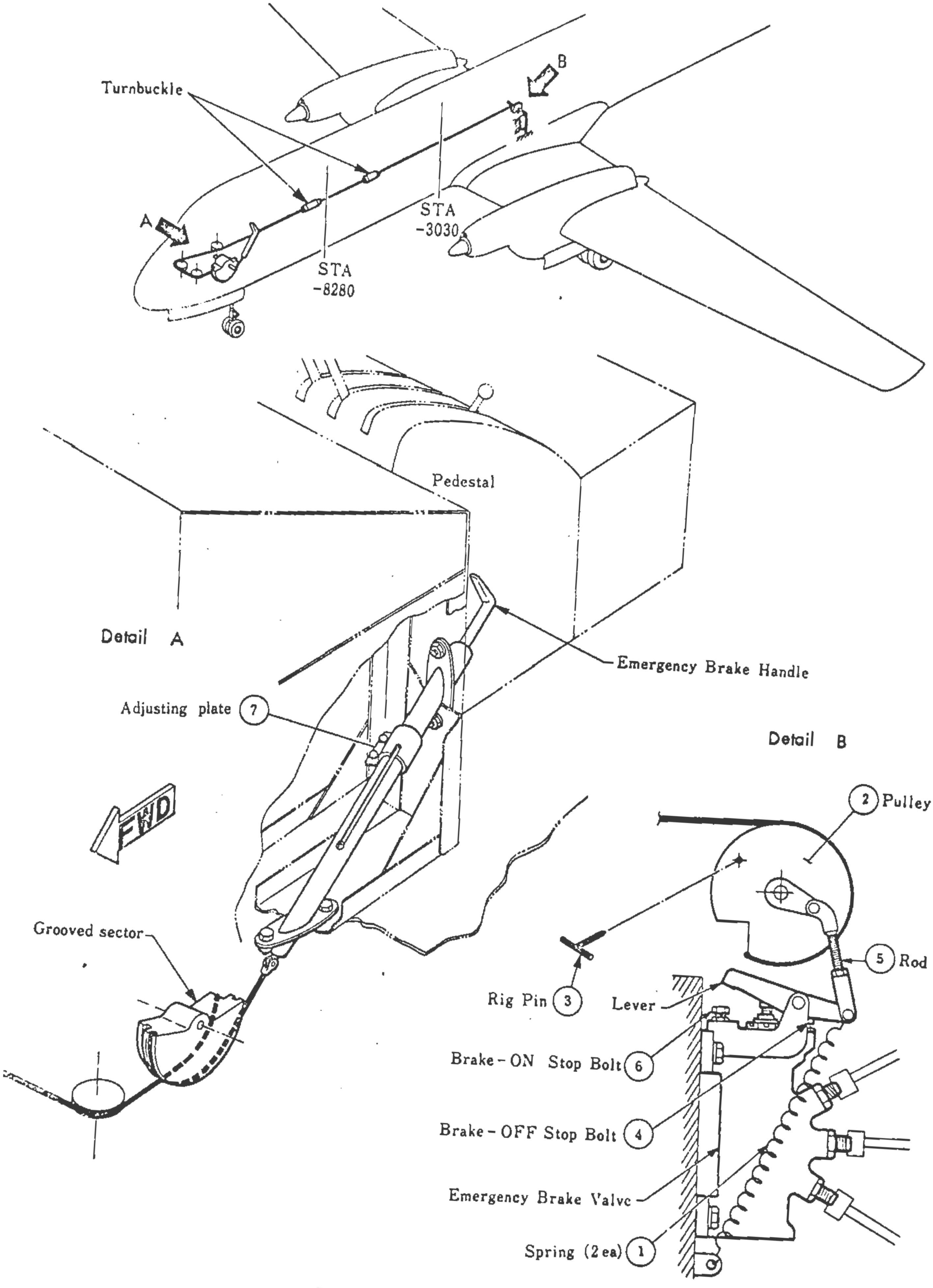
Note; When installing Stop Nut
Use 3/8"φ Bolt for convenience
of Procedure.
After installation, take it off

Installation of Joint & Drain

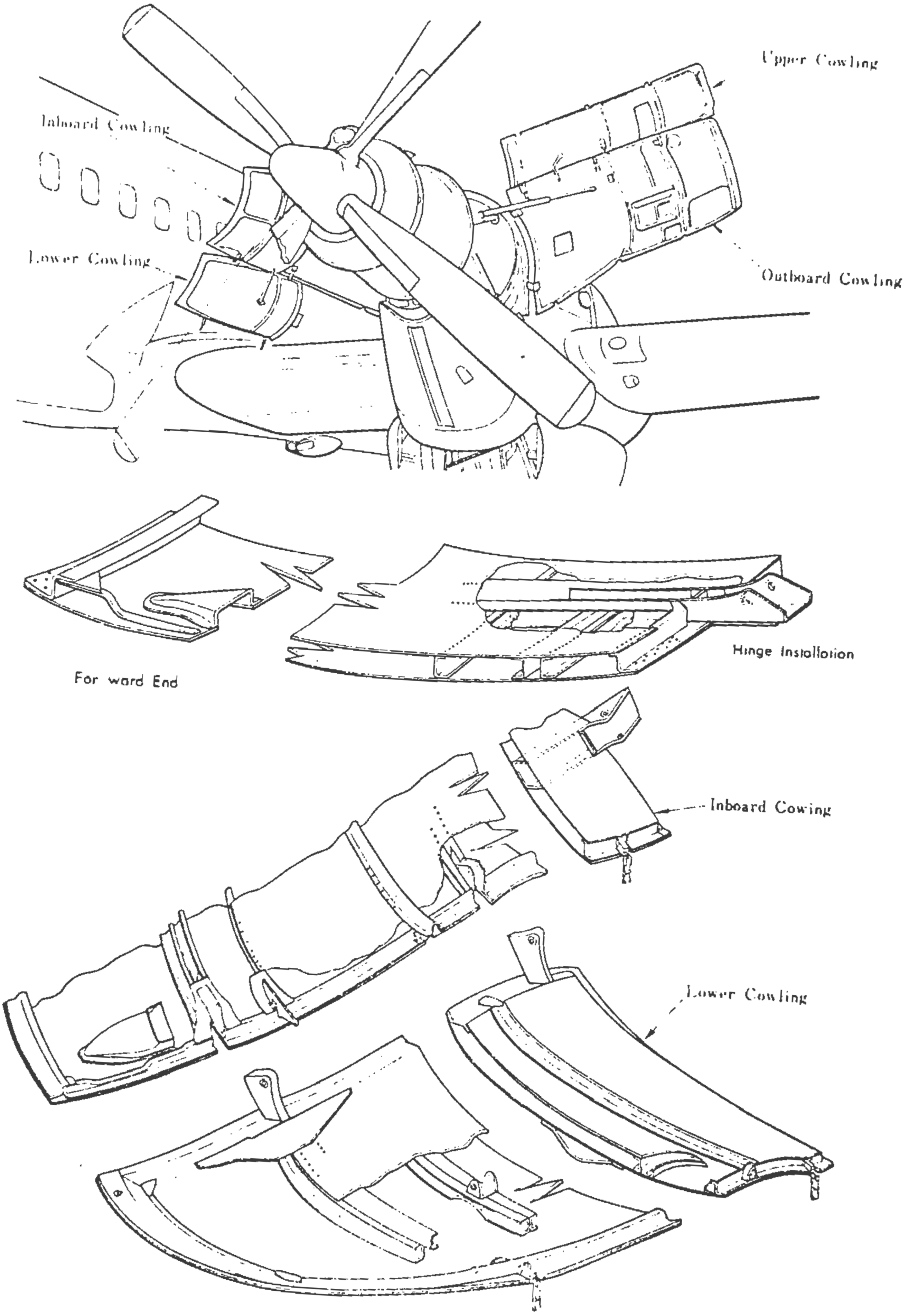
Figure 4-14



Joint of Exhaust Cone and Exhaust Pipe Assy
Figure 4-15

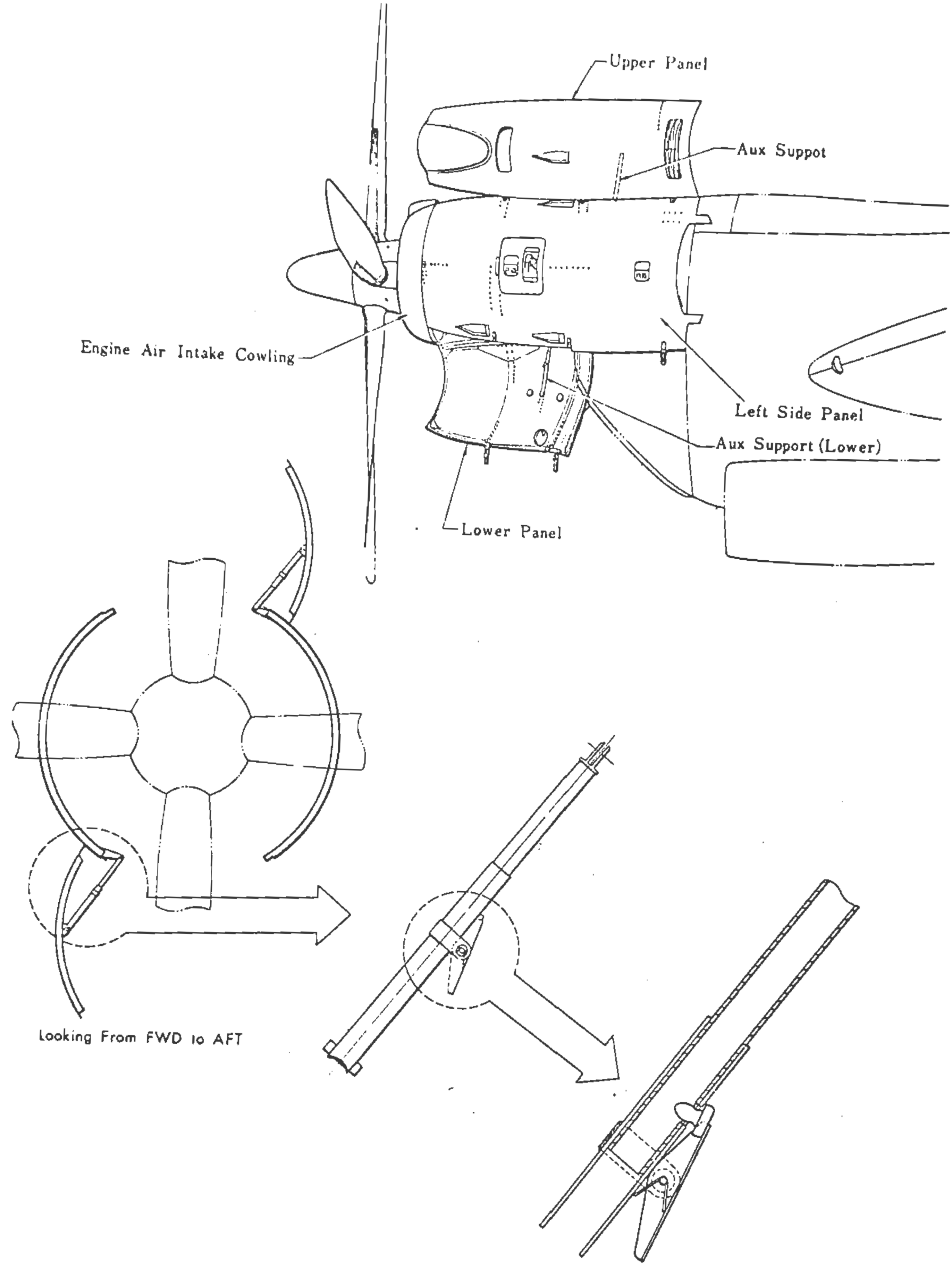


Rigging-Emergency Brake Mechanism
Figure 3–37



Engine Cowling Structure

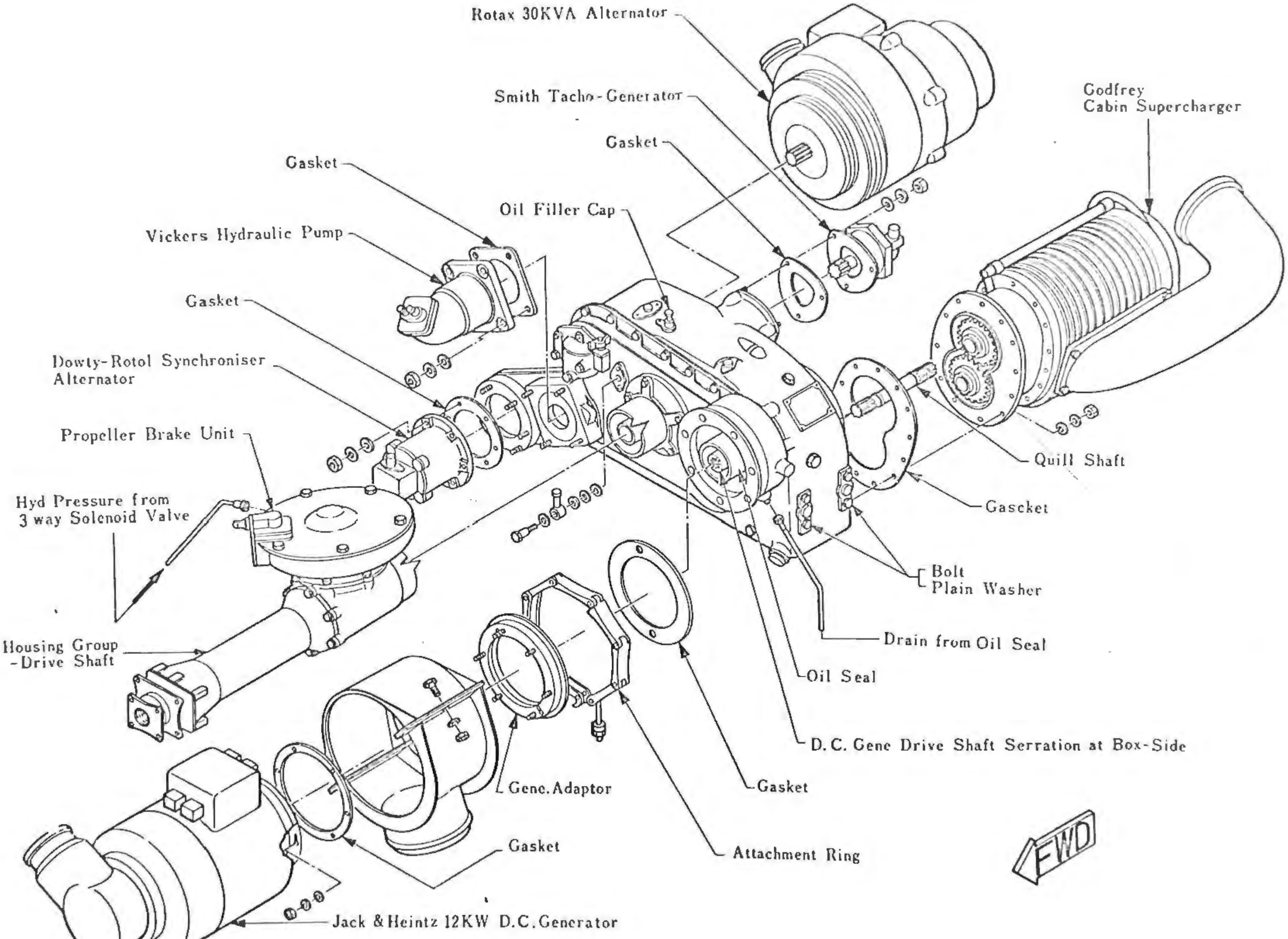
Figure 1-2



Looking From FWD to AFT

Detail of Aux Support

Engine Cowling
Figure 4–4



Accessory Gear Box Exproded View
Figure 4–10

4.6 Cooling and Ventilation System

4.6.1 Classification (See Fig. 4-11)

The cooling and ventilation system of the engine and gear box is described here.

The engine and the gear box areas are vented to cool them and accessories and to ventilate air around them. The nacelle is divided into the following 4 zones in view of fire protection:

Zone 1: This zone is located in the forward part of the engine between the rear part of the engine nose cowling and the engine fire wall.

Zone 2: This zone includes the engine hot section; combustion section and turbine section, extending rearwards from the aircraft fire wall, including the interior of the exhaust pipe.

Zone 3: This zone being the nacelle portion behind the aircraft fire wall, is divided into Zone 3 Upper and Zone 3 Lower.
Zone 3 Upper is separated from Zone 3 Lower by the shear panel and wing structures.

Zone 4: This zone is an area where the accessory drive gear box is provided, located in the forward, upper part of Zone 3 Upper, being separated from Zone 3 Upper by a bulkhead made of aluminum alloy.

4.6.2 System (See Fig. 4-11)

The cooling air enters Zone 1 from the air intake scoops provided 2 ea. in the forward lower part of the L.H. and R.H. panels of the cowling and 1 ea. (oil cooler) in the upper part.

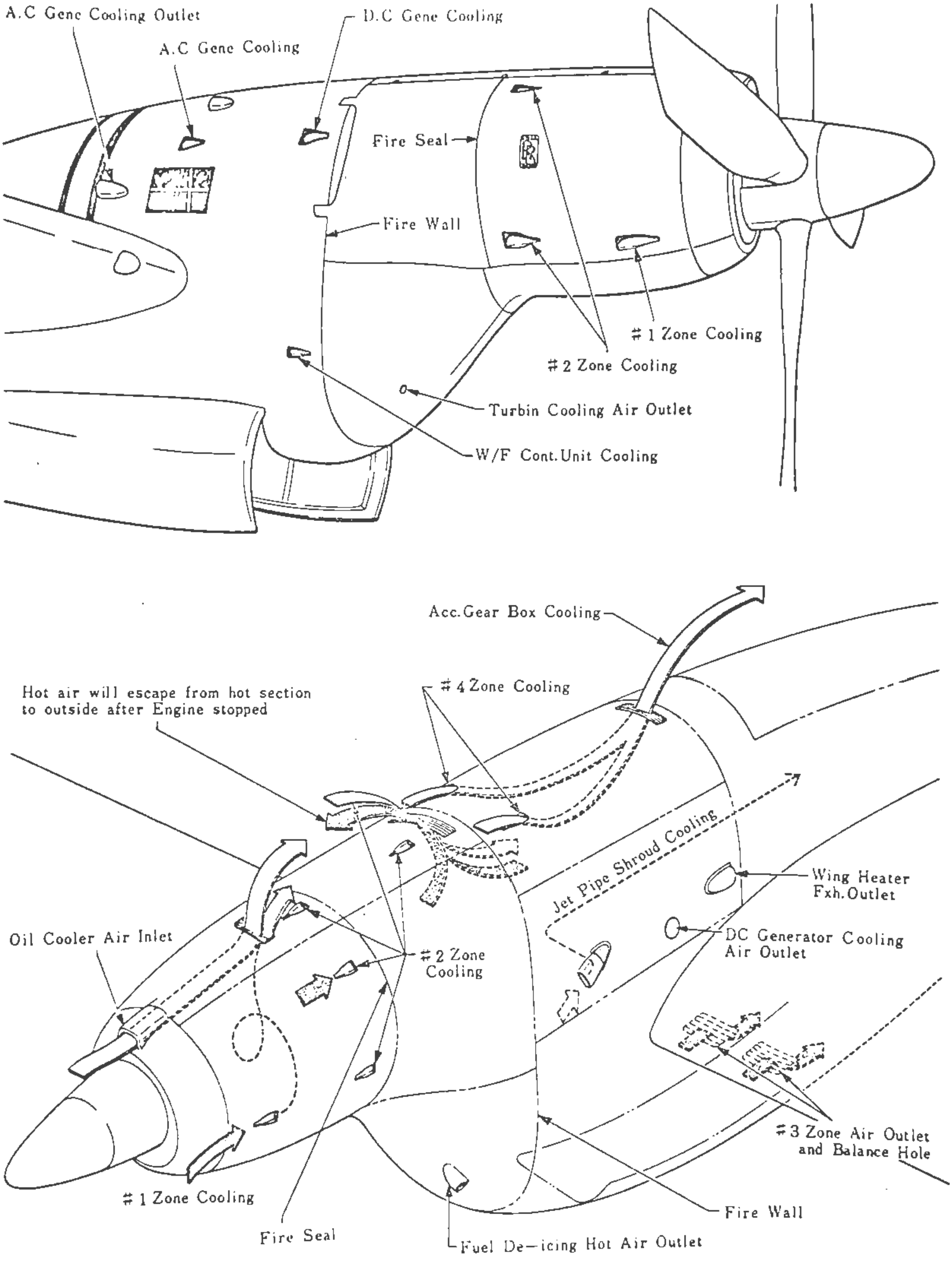
Air after cooling and ventilating Zone 1, is discharged from the engine oil cooler outlet port provided on the upper panel of the cowling.

In Zone 2 are provided 7 air intake cowlings. The air intake scoops are provided 2 ea. on the L.H. and R.H. cowling side panels and two on the top cowling, respectively. The louver type air intake is provided 1 ea. in the rear of the top cowling.

After the air entered from the air intake cooled the hot section of the engine, it flows along the annular gap between the engine exhaust unit and the exhaust cone shroud into the jet pipe and it is ejected outboard together with the engine exhaust.

The air intake scoop on the top panel is provided to cool the forward and rear universal joints of the gear box drive shaft.

The louver type air intake not only takes in air, but also discharges warm air to speed up cooling of the turbine section after the engine is shut down.



Power Plant Cooling and Ventulation.

Figure 4-11

The cooling air for Zone 4 enters from the 2 air intake scoops provided on the forward part of the gear box top cover and it is discharged from the louver type outlet provided in the rear of the gear box top cover after cooling the gear box and accessories.

After cooling the alternator control unit, air entered from the air intake scoop in the R.H. forward, lower part, ventilates Zone 3 Lower and is discharged from the louver type outlet located on the R.H. side of the nacelle close to the wing lower surface.

4.7 Exhaust System

4.7.1 Summary (See Fig. 4-12)

The exhaust system sends the hot gas from the turbine section over the wing upper surface and discharges it rearwards. The exhaust pipe consists of the exhaust cone shroud, jet pipe, blanket and jet pipe shroud. At its front end, the exhaust cone shroud is fixed to the aircraft fire wall with bolts, while its rear end can slide along the supporting fitting fixed to the jet pipe, permitting thermal expansion. To the rear end of the exhaust cone shroud are joined the jet pipe shroud on its outside and the jet pipe on its inside with flexible joints.

The exhaust pipes are interchangeable between the L.H. and the R.H. engines except the attachment of the supporting shaft for the rear support point which is symmetrical.

The exhaust cone shroud is installed around the engine exhaust unit. The cooling air of Zone 2 passing the gap between the above two, is led to the jet pipe by Venturi effect which is seen when the exhaust gas enters the jet pipe from the exhaust unit, making the coolings of Zone 2 more effective. The jet pipe is covered by blanket and furthermore by the shroud to prevent overheating of the structures around the jet pipe.

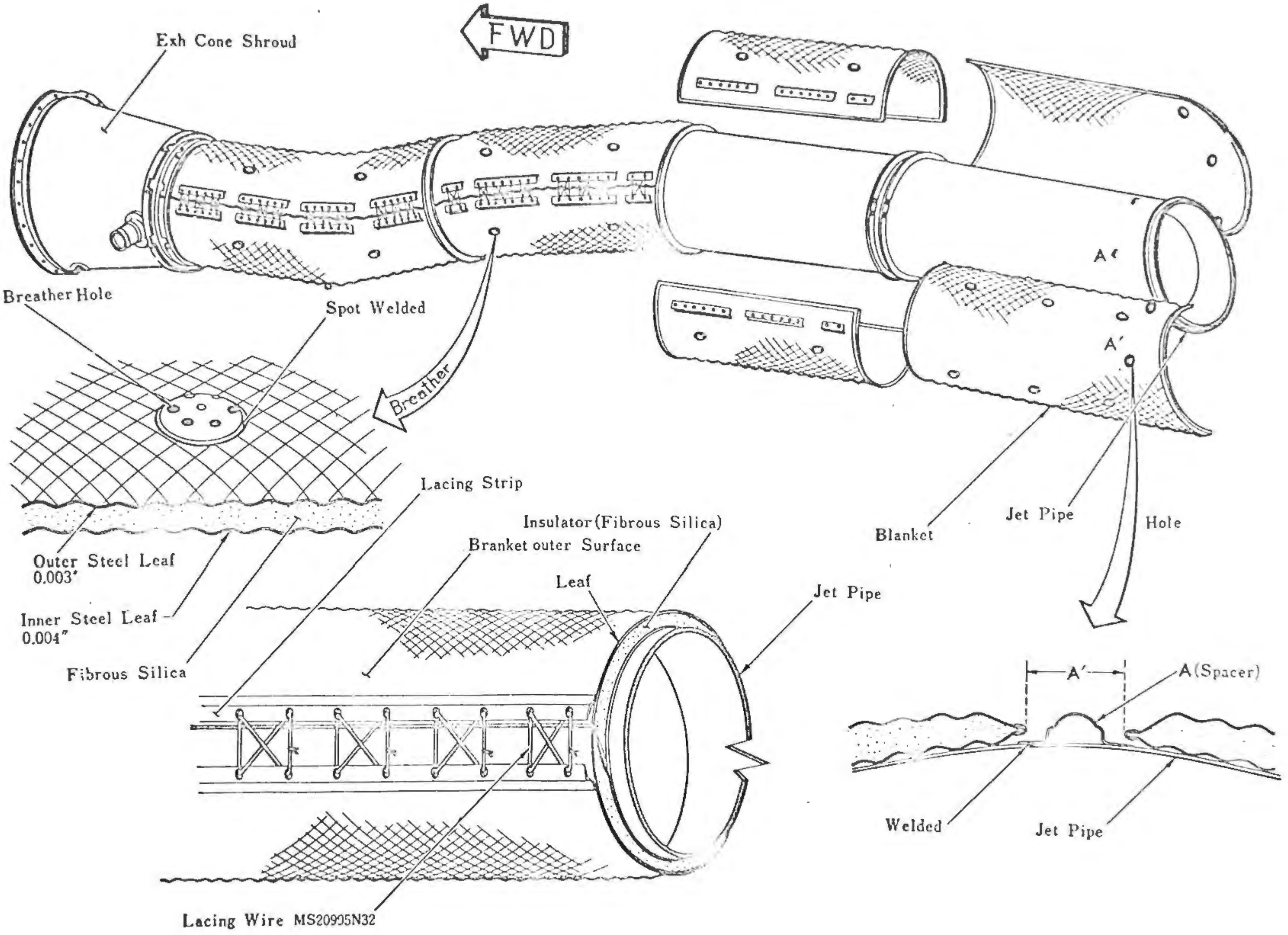
The cooling air taken in from the intake scoops on the sides of the nacelle passes the inlet duct of the exhaust cone shroud, passing the gap between the blanket and the jet pipe shroud and is discharged outboard from the rear end.

In order to prevent the exhaust gas discharged from the jet pipe from flowing back into the nacelle, the gap between the exhaust pipe and the nacelle structure is sealed with sealing cloth at the end.

4.7.2 Major Components (See Fig. 4-13, 14, 15, 16 and 17)

(1) Exhaust Cone Shroud

The exhaust cone shroud is of seam weld construction made of 347 corrosion resistant steel 0.032 in thick, approximately 480 mm long with the front diameter of approximately 635 mm and the rear diameter of 600 mm. The rear half is of double co-axial construction and air from the air scoop on the nacelle side is sent to the room between the two skins.



Blanket
Figure 4-16

(2) Jet Pipe

The jet pipe is of seam weld construction made of 347 corrosion resistance steel 0.032 in thick, approximately 3500 mm long, curved along the contour of the wing upper surface.

(3) Blanket

The blanket is made of heat shielding material sandwiched by corrosion resistant steel foils, the thickness being 0.5 in. The heat shielding material is made of laminated "Refrasil Fibrous Silica," fiber of silicon oxide, which is very light and can stand heat up to 1000°C.
In addition, it is a good insulator at elevated temperatures against heat and electricity. The stainless steel foils, 0.003 in thick outside and 0.004 in inside, are corrugated to increase strength and to permit expansion and its ends are welded to prevent entry of fuel, water etc.

In order to eliminate the pressure difference between the outside and the inside of the blanket when the engine is started or the operating conditions change, it is provided with breather holes which are covered by screens so that fluids can not enter them.

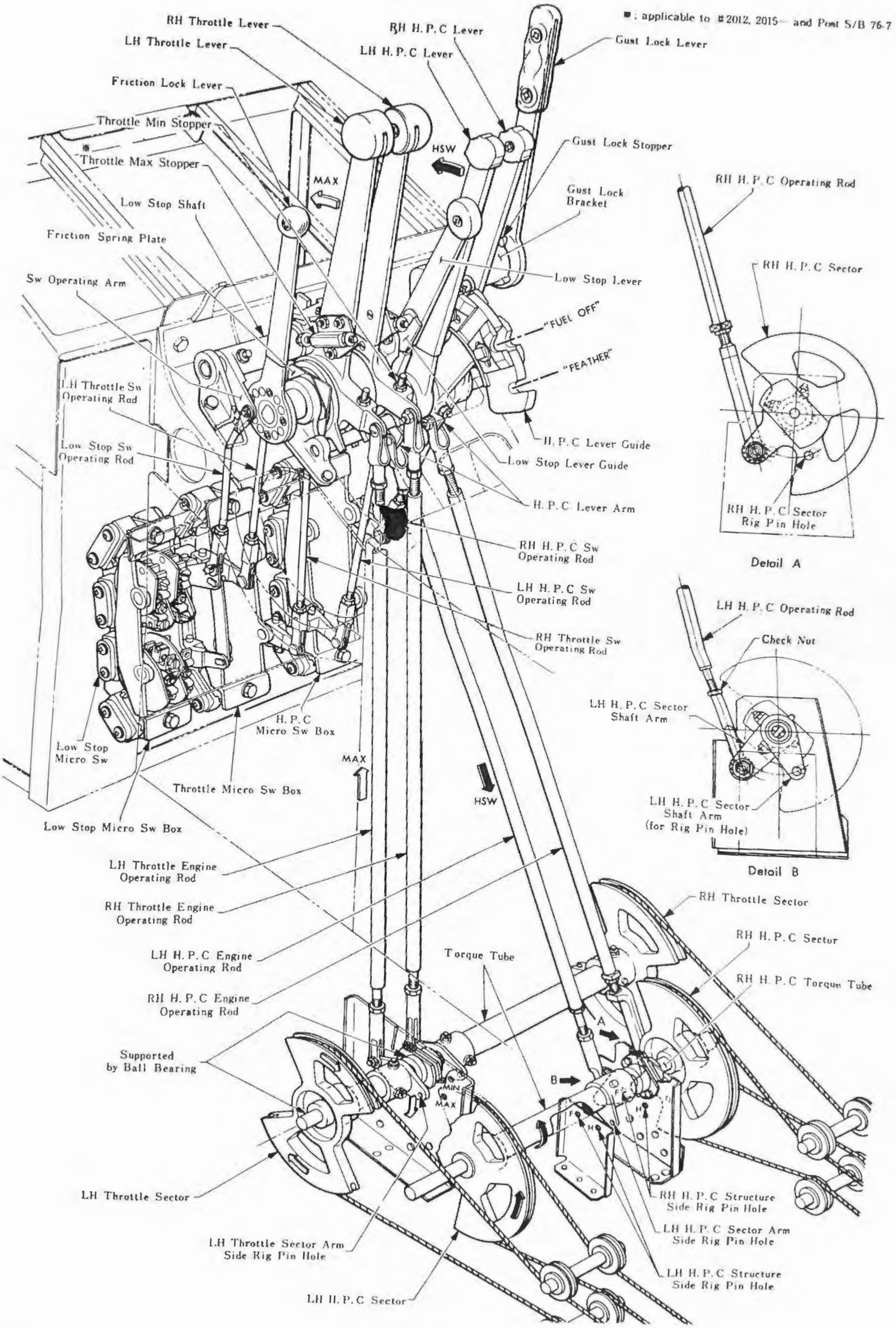
The blanket conforming to the shape of the jet pipe, consists of 4 pieces, each being divided into two parts, upper and lower.

(4) Jet Pipe Shroud

The jet pipe shroud is a structure of 2024-T4 seam welded pipes 0.025 in thick bolted together with a diameter of 470, split into 3 pieces.

On the lower surface of the lowest position of the curved section corresponding to the jet pipe drain hole is provided a drain connection through which fuel accumulated in the jet pipe goes down to the drain box in the nacelle.

The intermediate section is divided into the L.H. and R.H. halves with the upper and lower flanges bolted together and on the forward and rear sections of the upper flange are provided two lugs for lifting used when the shroud is removed or installed.



Pedestal Construction General View
Figure 4-18

4.8 Engine Control System

4.8.1 Summary of Power Control (Fig. 4-18)

The power control system consists of the following sub-systems:

Throttle Control System
Trim Control System
H.P. Cock Control System

The above controls are operated from the pedestal in the cockpit. On the pedestal are provided three levers (low stop, throttle and H.P.C.). On the lower ends of these levers are located micro switches.

(1) Features of Pedestal

A. The throttle lever, low stop lever or H.P.C. lever can be removed from the pedestal easily, independent of the others.

B. Not to mention the throttle micro switch which requires fine adjustment, the switches for the other two levers can be finely adjusted.

C. Micro switches (amounting to 22) are neatly arranged in the comparatively scanty forward space of the pedestal. Any one of them can be easily replaced if necessary.

(2) Features of Each Lever Control Linkage

A. On the ends of cables in the L.H. and R.H. nacelles are installed the end pulleys symmetrically. In the L.H. nacelle, the synchro corrector unit is tied in the throttle lever control.

B. When both throttle and trim control systems are rigged, it is important to confirm the datum position of the corrector unit.

C. The end pulley (nacelle quadrant) and the engine control box are linked together with push pull rods and control rods.

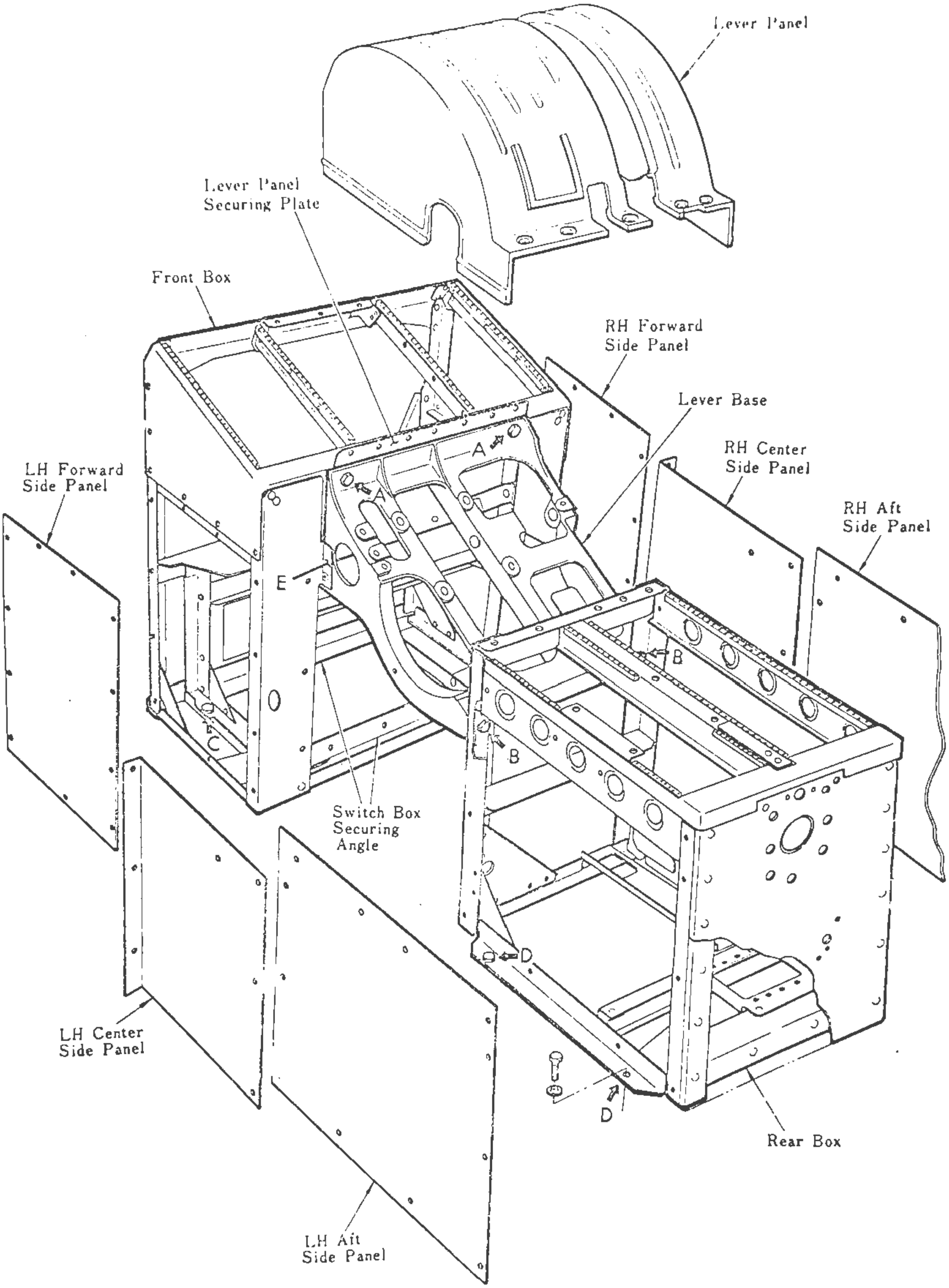
D. As long as the aircraft side rigging is concerned, the throttle system, H.P.C. system or trim system moves independent of the others. However, they can move independently only up to the engine control box and from this point on, they are mutually interrelated in their movement.

4.8.2 Composition and Functions of Pedestal

(1) Structure of Pedestal Frame (Fig. 4-19)

The pedestal consists primarily of the following three parts:

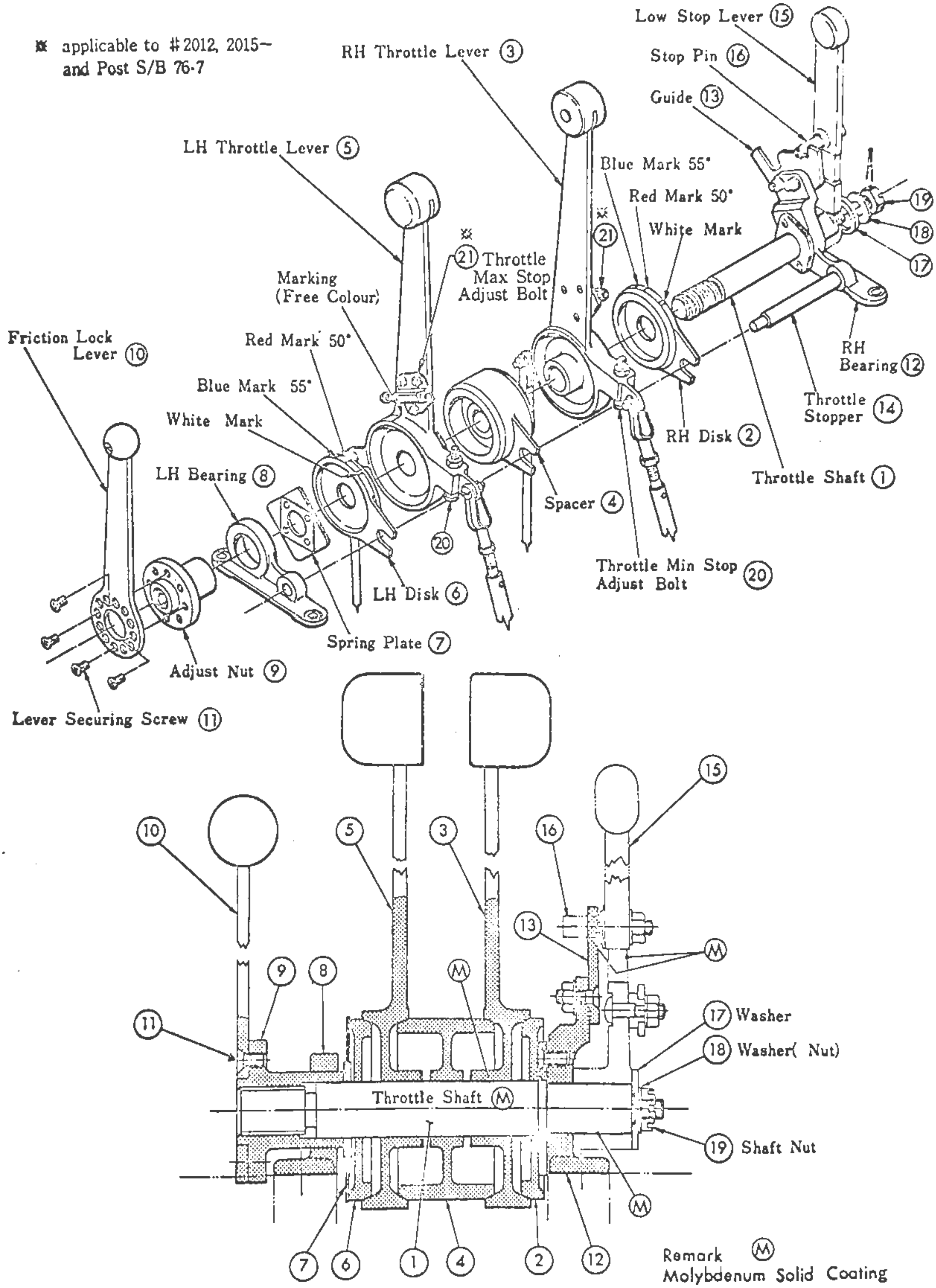
Front box	In the box is contained a box in which micro switches are installed.
Lever base	On the base are installed levers and their shafts.
Rear box	On the upper surface are installed a control panel for the W/M and trimmer.



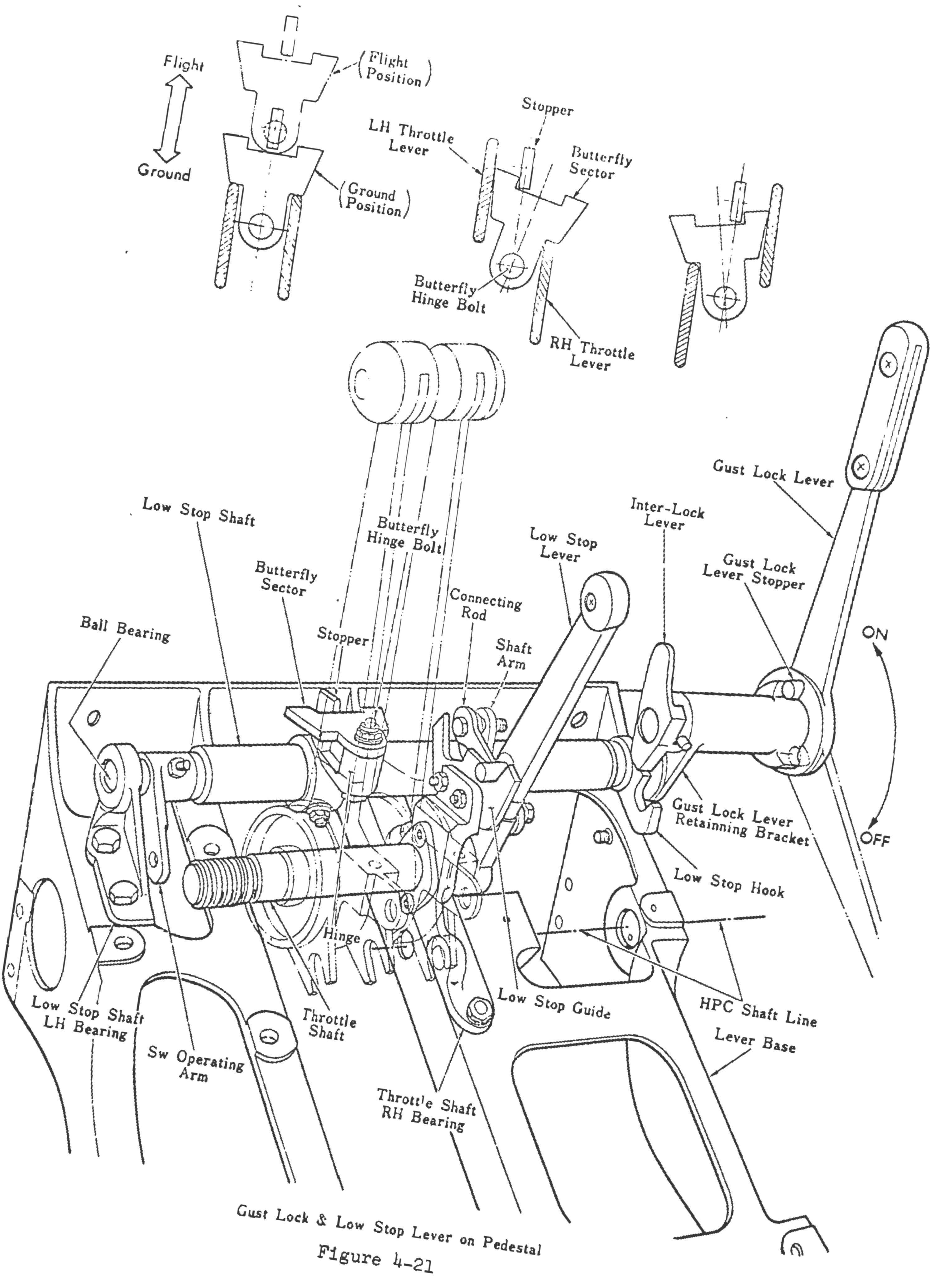
Pedestal Frame Construction

Figure 4-19

※ applicable to #2012, 2015~
and Post S/B 76-7



Throttle Friction Lock on Pedestal
Figure 4-20



Gust Lock & Low Stop Lever on Pedestal

Figure 4-21

The right end of the shaft is supported by the same ball bearing. This bearing is caulked in the gust lock lever mounting bracket.

The bracket itself is mounted on the front box side and the lever base side with two bolts, respectively.

On the low stop shaft are mounted two arms, a hinge and a hook, integral with the shaft.

The switch operating arm on the left hand moves the low stop micro switch actuating rod. The low stop hook on the right hand is linked to the inter-lock lever of the gust lock system.

If the low stop lever is pushed forward, the shaft rotates forward and the hinge at the center of the shaft catches the butterfly sector. This butterfly sector prevents both throttles from opening fully at the same time when the gust lock is on.

In order to determine the low stop lever positions clearly, the flight position and ground position dents are provided on the guide.

As the movement of the low stop lever is affected by the gust lock lever position, the low stop lever can not be placed in the flight position if the gust lock lever is not disengaged. The ground position can be obtained if the low stop lever is pulled up and rearwards.

(4) Details of H.P.C. Lever (Fig. 4-22)

The H.P.C. lever rotates around the H.P.C. shaft and the H.P.C. lever guide is mounted on the H.P.C. shaft with the guide securing bolts.

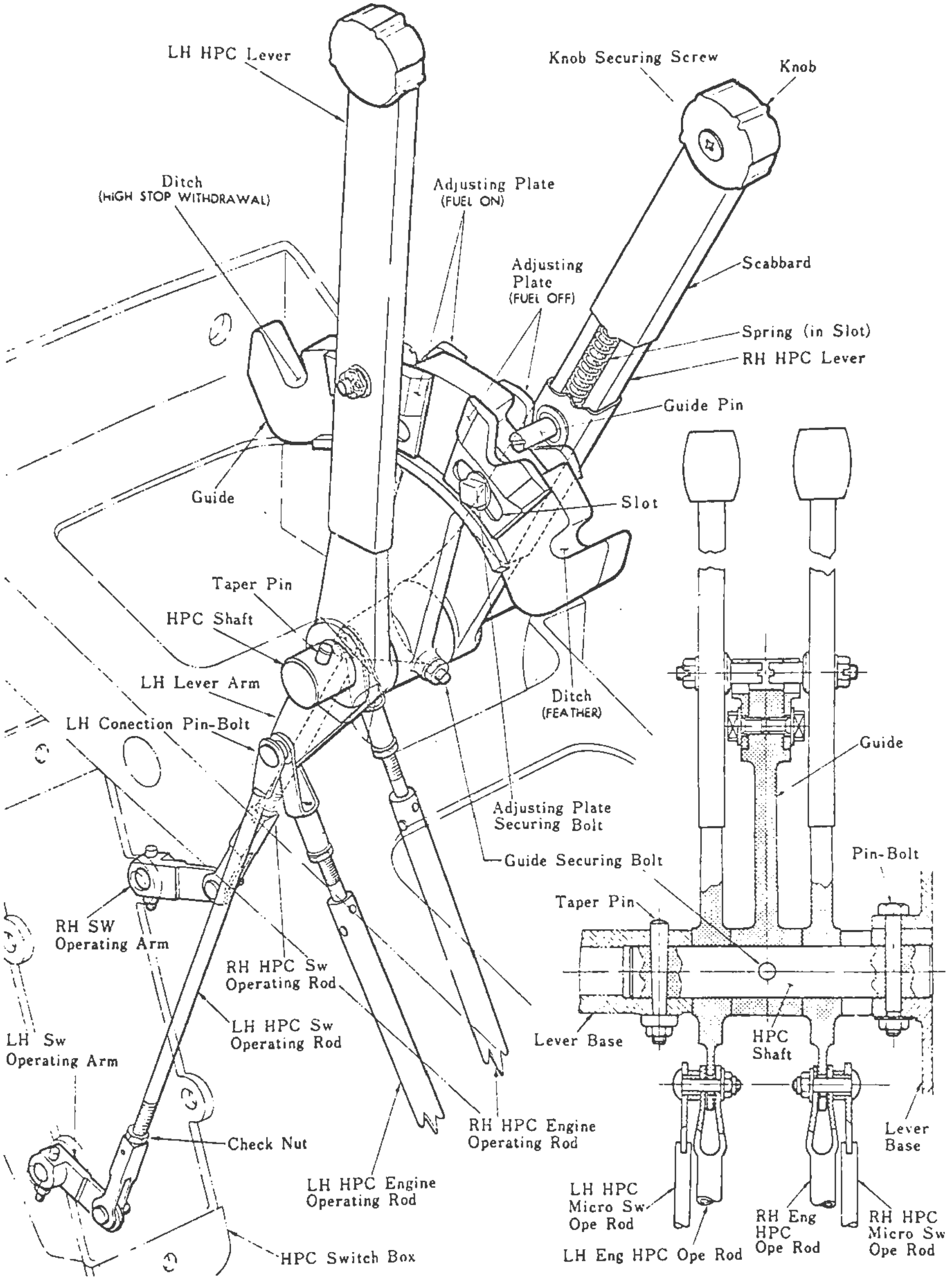
The L.H. and R.H. levers are connected to the rods actuating the L.H. and R.H. micro switches in the switch boxes, respectively.

At the same time, the L.H. and R.H. engine operating rods are connected to the lever arms. The guide has the following four lever position dents:

High Stop Withdrawal
Fuel On
Fuel Off
Feather

If the H.P.C. lever is placed in the high stop withdrawal position, the "L.O." mark is selected in the control box on the engine side. The H.P.C. control system is adjusted at this position. "FUEL ON" and "FUEL OFF" positions are determined with the dent positions of the guide by adjusting the H.P.C. lever slots to the engine installed.

"FEATHER" position is so designed that the lever is caught by "F" stopper of the engine control box on its way and it serves as the reference point when the micro switches are adjusted.



HPC Lever on Pedestal

Figure 4-22

4.8.3 Relativity of Gust Lock, Low Stop and Throttle (Figs. 4-21 and 23)

The throttle and the low stop are mechanically connected to the gust lock lever so that the aircraft can not be taken off without disengaging the gust lock.

(1) Both L.H. and R.H. throttle levers can not be advanced to the max. power position when the gust lock is on. Either one can be moved to the position at a time.

(2) The low stop lever can not be moved manually from the ground position to the flight position when the gust lock is on. On the contrary, the gust lock can not be engaged when the low stop lever is in the flight position.

(3) When the gust lock is disengaged, the L.H. and R.H. throttle levers can be moved to the max. position at the same time and the low stop levers can be moved manually to the flight position easily. If the pilot advances both throttle levers, paying no attention to the low stop levers, the throttle levers drag the low stop levers to the flight position.

4.8.4 Composition of Micro Switch Groups (Fig. 4-24)

(1) Composition of Groups

The micro switch groups consist of the following three:

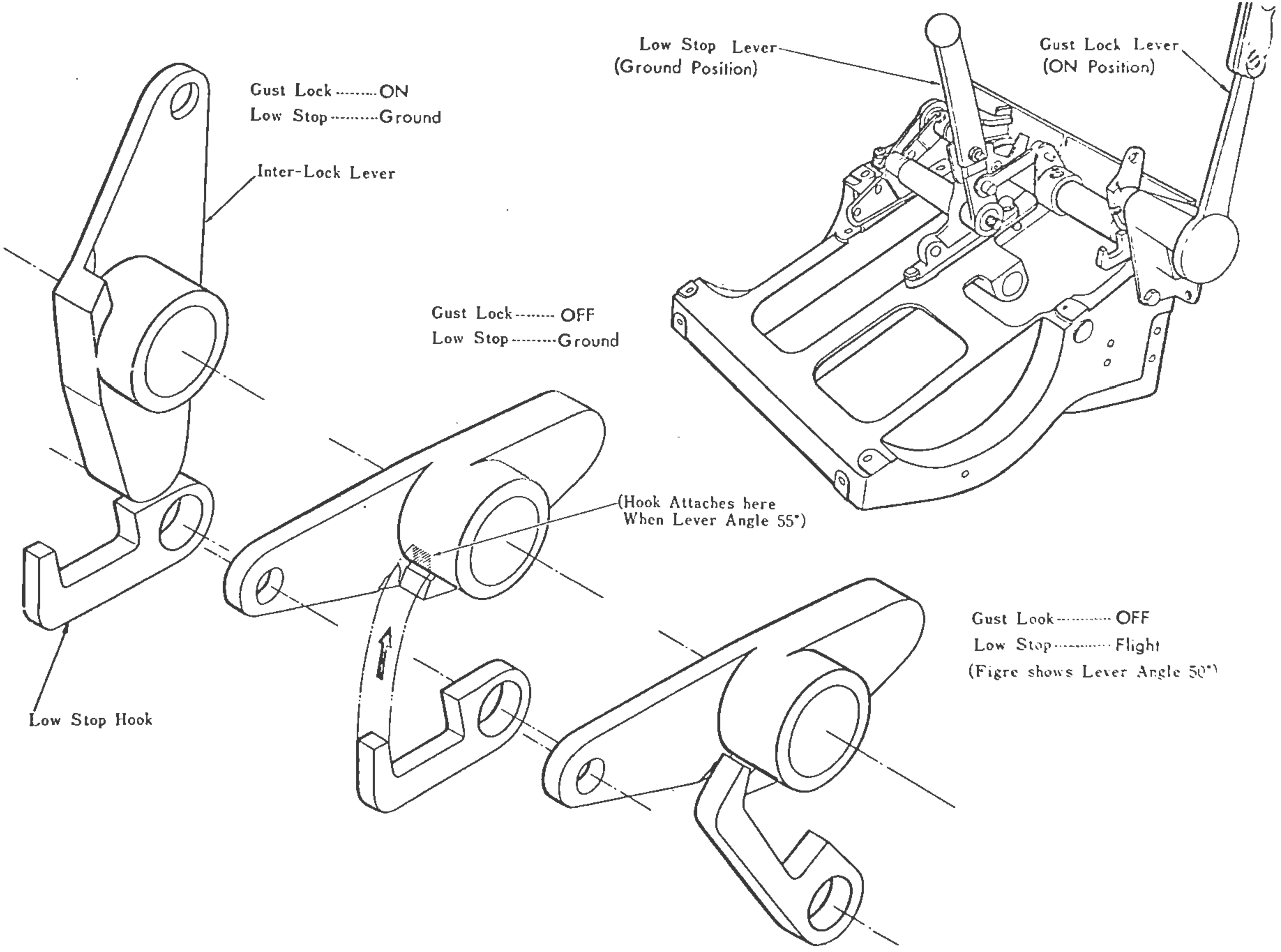
Throttle Switches	F1 to F8 (8 micro switches)
Low Stop Switches	L1 to L7 (7 micro switches)
H.P.C. Switches	a, a', b, b', c, c', d (7 micro switches)

(2) Composition and Functions of Adjuster

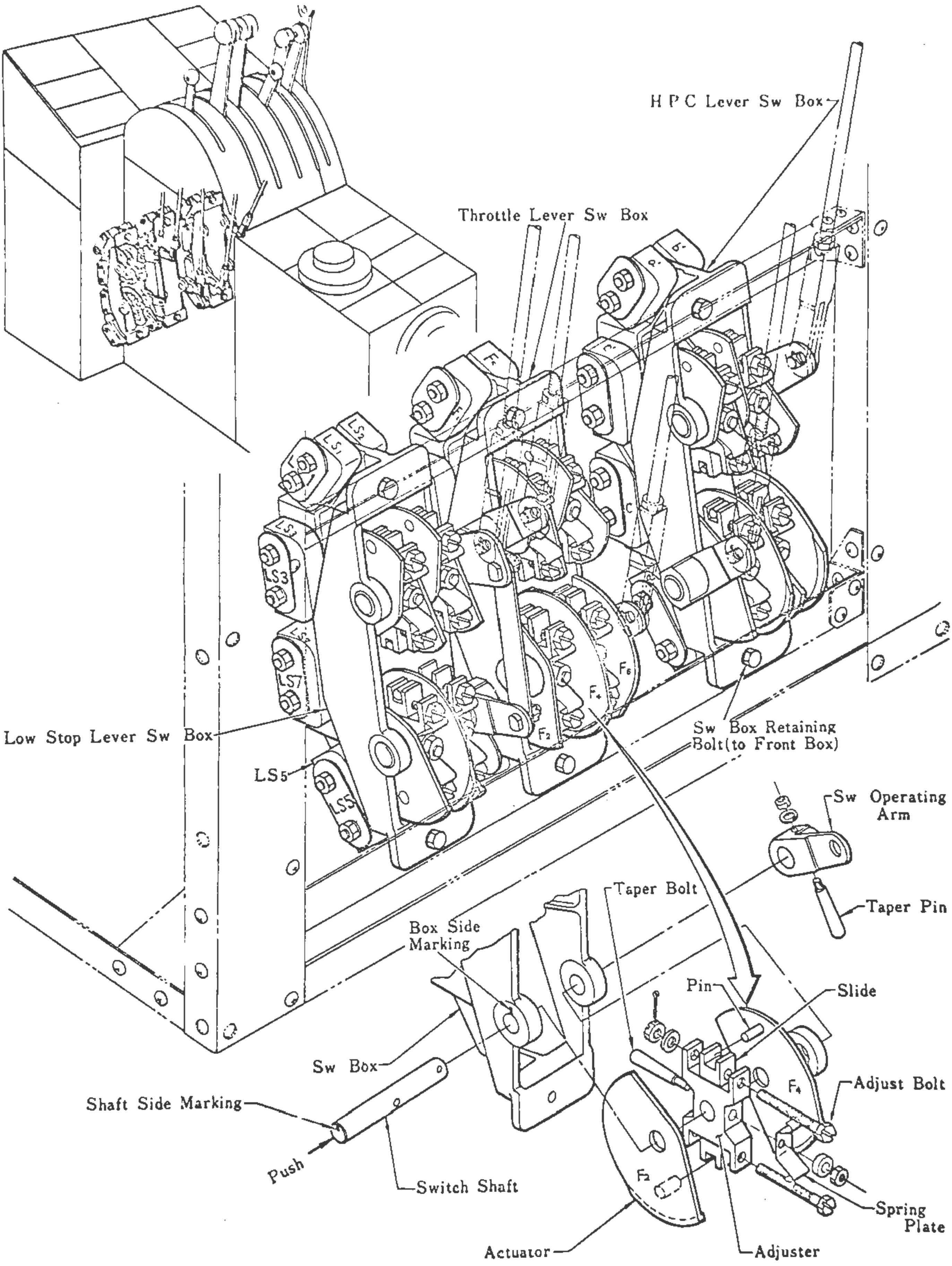
On the adjuster in H shape are provided slides 1 ea. on the upper and the lower parts. The slide with thread inside can be moved laterally by rotating the adjust bolt.

The switch shaft has been so designed that it moves together with the two adjusters. The actuators are essentially cam plates with different shapes. The locking positions of the pins are all different slightly.

NOTE: The pitch of the adjust bolt of the micro switch actuator to be adjusted is 0.8 mm. The maximum amount of correction is approximately 8° of the rotating angle of the actuator which correspond to approximately 1,200 r.p.m. of engine speed at the throttle switch.



Interrelationship of Gust Lock and Low Stop
Figure 4-23



Micro Switch & Cam Installation.

Figure 4-24

(3) Summary of Types and Operation of Micro Switches (Fig. 4-25)

Types of Switches

a. BZ-7RDT and BZ-7 RWT822

Since the terminals are of normal-open type or normal-close type depending on usages, the electrical circuit may be open even when the switch is pushed in and it may be closed even when the switch is released.

b. BZ-3YDT

As both terminals (normal open and normal closed) are in use, the open and closed electrical circuits exist at the same time when the switches are in "PUSH" and "RELEASE" conditions.

(4) Summary of Throttle Micro Switch

The following micro switches come into action successively as the lever moves from the min. position to the max. position:

F1, F2 ..... If the engine throttle is retarded to this point on its way to the idle position when the main gear is not down-locked, the landing gear warning bell rings. This is intended to prevent landing with landing gear up.

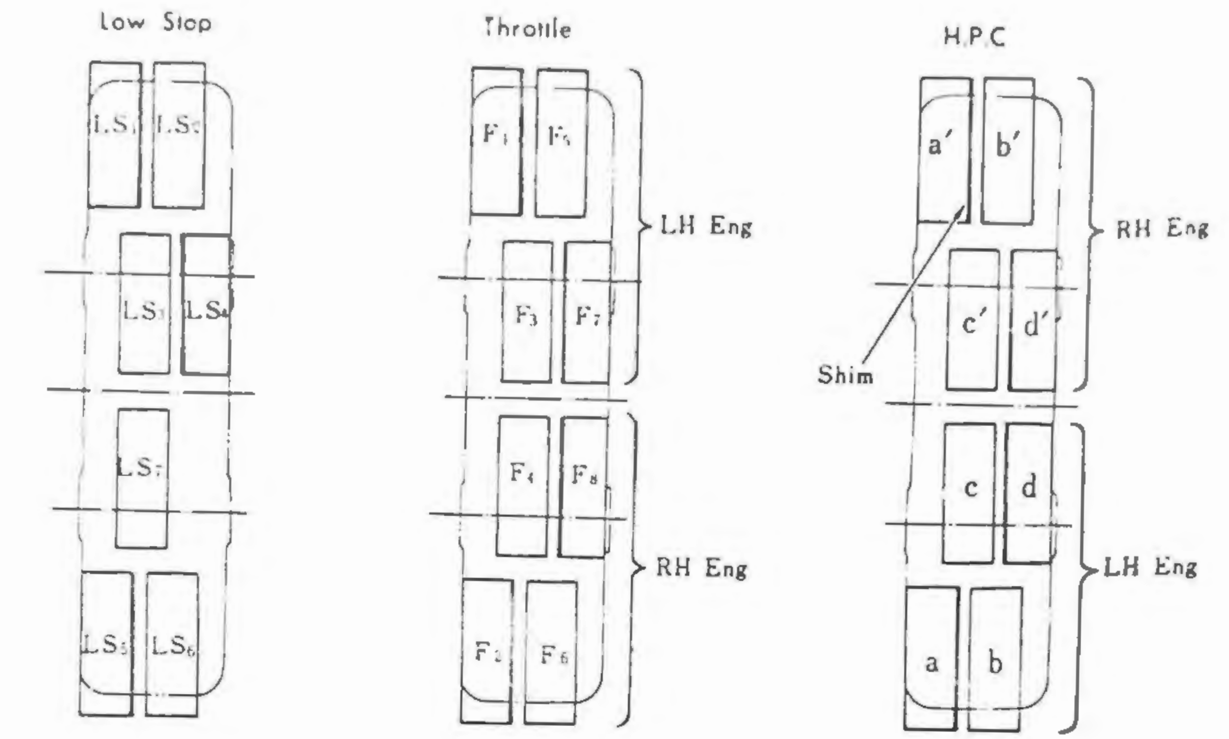
F3, F4 ..... This switch closes the auto feather circuit of the propeller control system at around 12,800 to 13,000 rpm. If the torque value drops below 50 psi while the lever is located in a more advanced position, the propeller auto-feathering takes place.

F5, F6 ..... This switch opens the spill valve of the air control system at 380 lb/hr of fuel flow. This is intended to smooth acceleration at the time of engine starting. If the low stop lever is placed in the ground position, the ground spill takes place. If it is in the flight condition, the ground spill does not take place.

F7, F8 ..... This opens the spill valve so that the take-off power is not used for accessory driving at 14750 to 14950 rpm.

(5) Summary of Low Stop Micro Switch

LS1, LS2.... If the lever is in the flight position, this closes, performing the following functions: If the propeller pitch moves 2° below the flight fine pitch during flight, the warning light comes on for corrective action and the solenoid is energized to coarsen the pitch. As the pitch is coarsened, the blade cam cuts off the electric power supply.



Sw Type
$LS_1 \sim LS_7$: BZ7RWT822

Sw Type
$F_1 \sim F_8$: BZ7RDT

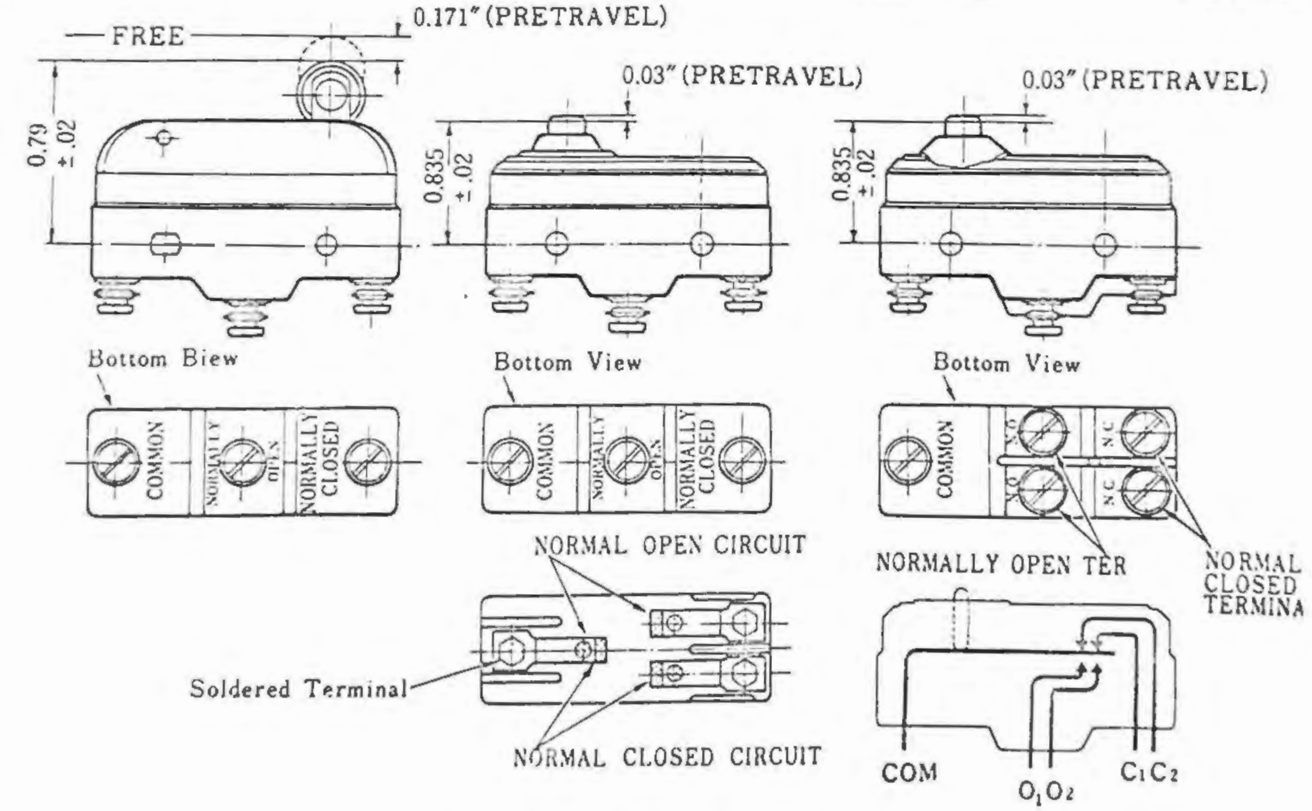
Sw Type
b'.d.b : BZ3YDT
Others : BZ7RWT822

Micro Sw Groups on Pedestol
(Looking from Aft to Fwd)

BZ-7RWT822
MOVEMENT DIFFERENTIAL = 0.02~0.05"
OVERTRAVEL = 0.094" MIN

BZ-7RDT
MOVEMENT DIFFERENTIAL = 0.001~0.006"
OVERTRAVEL = 1/16" MIN

BZ-3YDT
MOVEMENT DIFFERENTIAL = 0.001~0.006
OVERTRAVEL = 1/16" MIN



Three Types of Micro Switches

Micro Switches Groupes on Pedestal

Figure 4-25

LS3, LS4..... This closes when the lever is in the ground position, performing the following functions:
This energizes the solenoid which release the flight fine pitch stopper, permitting fine pitch adjustment up to 0° on the ground.

LS5, LS7..... This closes when the lever is in the ground position. This energizes RL5 relay to generate 150V wild frequency AC during engine run up on the ground.

LS6 .... This opens when the lever is in the flight position. This switch cuts off electric power to F5 and F6 so they do not come into action in flight. That is to say, this does not permit the spill valve to open in flight even though the lever is retarded below 11,000 rpm.

(6) Summary of H.P.C. Lever Micro Switch

The working points of the switch varies as shown in the following table, depending on the positions of H.P.C. lever:

	High Stop Withdrawal	Fuel ON	Fuel OFF	Feather
aa'	Close	Close	Close	Open
bb'	Close	Close	Open	Open
cc'	Open	Open	Open	Close
d	Open	Open	* Close	Open

"* Close" indicates that the propeller brake circuit is made when H.P.C. lever is in "Fuel OFF" position.

The switch a is provided in the auto feather circuit of No. 2 engine and No. 2 engine can not be auto-feathered if No. 1 engine is feathered already.

Consequently, the switch a comes into action only when

a. No. 1 auto coarsening relay is dead,

b. No. 2 engine torque is below 50 psi,

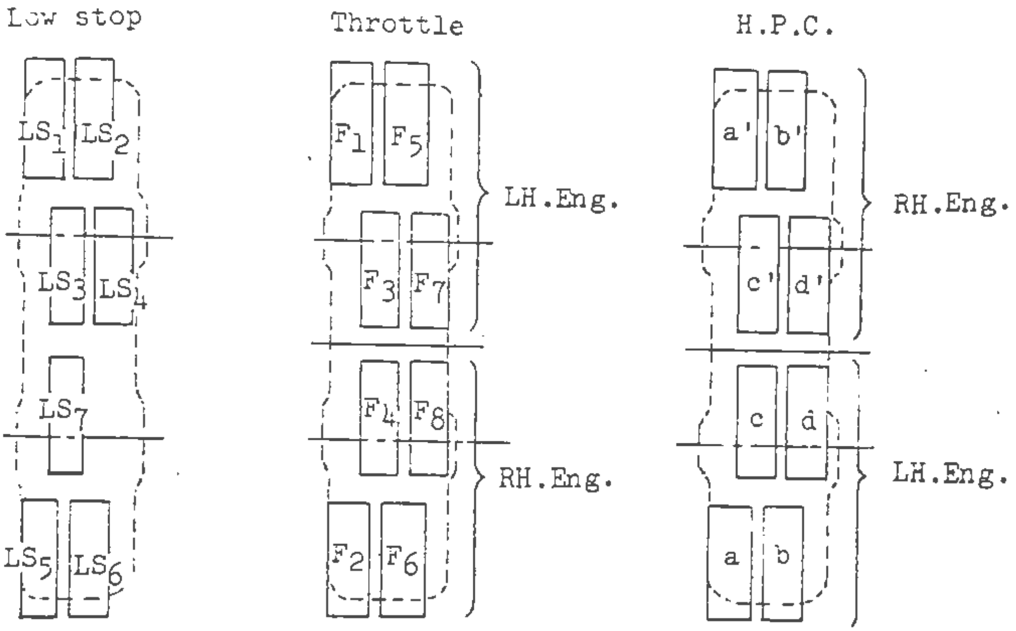
c. No. 2 throttle lever is placed in a lever position above 12,000 rpm and,

d. R.H. H.P.C. lever is placed in the fuel on or high stop withdrawal position.

Under the above conditions, the propeller is feathered if the auto coarsening relay is energized.

When the H.P.C. lever is in the OFF or feather position, the switch b closes the W/M shut-off valve. Therefore, W/M can not be supplied even if W/M injection is tried.

The switch d in the propeller brake system, permits power from the D.C. emergency bus to flow to the propeller brake switch when the H.P.C. lever is in the fuel off position. Then, the brake can be applied to the propeller.



Micro Switch Groups on Pedestal

Low Stop Lever Switch

Switch Symbols		Low Stop Lever Position		System Involved	Control System
L.H.Eng	R.H.Eng	Ground	Flight		
LS_2	LS_1	Open	Close	Flight Fine Pitch Elect - Hyd. Stop (Pitch Coarsening Solenoid)	Propeller Control
LS_3	LS_4	Close	Open	Low Stop Withdrawal Solenoid	Propeller Control
LS_5	LS_7	Close	Open	Voltage Change Over Switch 150V ⟶ 204V	Elect. System Wild Frequency Power Source
LS_6		Close	Open	Spill takes place below 380 lb/hr of fuel flow in the ground position	Air Conditioning Spill

Throttle Lever Switch

Switch Symbols		Lever Position			Requirements for Switch Change-over Point	
L.H.Eng.	R.H.Eng	Min.	Change-over point	Max.	Requirements for Operation	Requirements shown in terms of throttle lever angle of F.C.U.
F_1	F_2	Close	0	Open	Fuel Flow 700 ± 20 lb/hr	15°44' ~ 17°10' Warning for landing gear
F_3		Open	0	Close	Engine Speed 12,800~13,000rpm	28°30' ~ 30°30' (Low Torque Switch)
	F_4	Open	0	Close		
F_5	F_6	Close	0	Open	Fuel Flow 380 ± 20 lb/hr	4°18' ~ 5°46' Air conditioning spill valve shut
F_7		Open	0	Close	Engine Speed 14,750~14,950rpm	48°40'~51°50' Air conditioning spill valve open
	F8	Open	0	Close		

H.P.C. Lever Switch

Switch Symbols		Lever Position				Control System
L.H.Eng.	R.H.Eng.	High Stop Withdrawal	Fuel ON	Fuel OFF	Feather	
a	a'	Close	Close	Close	Open	Prop. Control Auto Coarsening Circuit
b	b'	Close	Close	Open	Open	Prop. Control W/M Act. Relay
c		Open	Open	Open	Close	Prop. Control Automatic Coarsening
	c'	Open	Open	Open	Close	
d		Open	Open	Close	Close	Stair Way Circuit

4.8.5 Throttle Control System (Figs. 4-26 and 27)

(1) General

The throttle control system controls engine fuel flow and selects the engine speed with a single lever and it also controls W/M injection. The linkage on the aircraft side transmits the throttle lever action over its entire range to the engine control box throttle pick up lever exactly. On the L.H. nacelle is provided the corrector unit of the propeller synchronizer system.

(2) Composition of System and Summary of Components

The components move in the following sequence:
Lever → Rod → Torque Tube → Sector → Cable → Control Rod
→ Engine Pick up Lever.

A cable is used between the quadrant sector in the center pedestal and the quadrant in the nacelle. The nacell quadrant and the engine pickup lever are connected with rods.

Three turnbuckles are used in the cable. At the fuselage--wing joint is used a pressure seal on which MIL-G-7187, grease is applied.

At the nacelle quadrant is provided a friction damper with which the throttle lever can be maintained at a given position.
The torque of the friction damper is so adjusted that the throttle lever can start moving at 35 to 40 in.lb.

On the left hand side is installed the synchronizer corrector motor. The synchro arm rotates around the eccentric shaft of the corrector unit.

When the synchronizer system is turned off, the synchro arm only relays the motion of the push pull rod. When the throttle is to be rigged, it is necessary to set it to the datum line with a special tool installed. Otherwise, the datum position can not be determined.

(3) Requirements of Throttle Operation

When both throttle levers in the cockpit are advanced fully together, the throttle pickup levers in the engine control box must come in contact positively with the max. stoppers on the control box side. Likewise, they must come in contact positively with the min. stoppers when the levers are retarded fully.

(4) Propeller Synchronizer

A. Summary

The propeller synchronizer is provided to synchronize the L.H. and R.H. engines, reducing vibrations to the aircraft, discomfort to crew and passengers, noises etc. due to the speed difference of both engines and relieving the pilots from incessant burden of engine control.

The R.H. engine serves as the master engine. Consequently, the R.H. engine is not affected by this unit, the L.H. engine being the slave engine. That is to say, the speed of the L.H. engine is maintained equal to that of the R.H. engine by means of the synchronizer control unit.

B. Mechanism

On the gear boxes of the L.H. and R.H. engines are installed the synchronizer alternators. On the L.H. engine is provided a corrector motor connected to the engine power control linkage.

Signals corresponding to the difference of speeds of the L.H. and R.H. alternators are sent to the corrector motor which regulates the engine fuel flow and the propeller control unit.

Actually, the throttle linkage moves the engine control system by means of the friction damper, not by moving the throttle lever by means of the corrector motor.

Do not move the throttle abruptly lest the datum setting of the synchronizer motor should go wrong.

C. Operation

This unit can be operated by turning on the synchronizer switch in the cockpit.

The maximum adjustable range of speed is approximately ± 250 rpm due to structural characteristics of the synchronizer unit which is effective only when the throttle is in the constant speed range of 11,000 to 15,000 rpm.

If the engine speed correction is desired or any unstable condition is noticed while the synchronizer is in use, turn off the synchronizer once and turn it on after readjusting the throttle.

When the throttle is placed at the min. constant r.p.m., the engine speed depends on the P.C.U. only and the synchronizer does not work.

During climb and cruising, the unit has tolerances of + 100 rpm for a desired mean speed (average of the L.H. and R.H. engine speeds).

Turn off the synchronizer switch during take-off and landing. Otherwise, the speed of the slave engine will be affected if the master engine failed.

4.8.6 Fuel Trim Control System

(1) General (Figs. 4-28 and 29)

The rise of the outside air temperature decreases the engine intake air mass flow at any engine speed.

If the fuel flow remains unchanged under such circumstances, the mixture ratio becomes too rich, elevating the turbine temperature excessively. Therefore, the fuel flow must be reduced as the ambient temperature increases. For this purpose is provided the trimmer. The trimmer does not change the engine speed but changes the fuel flow only. This can be accomplished by restricting the throttle valve opening of the F.C.U. with the trimmer.

(2) Summary of Operation

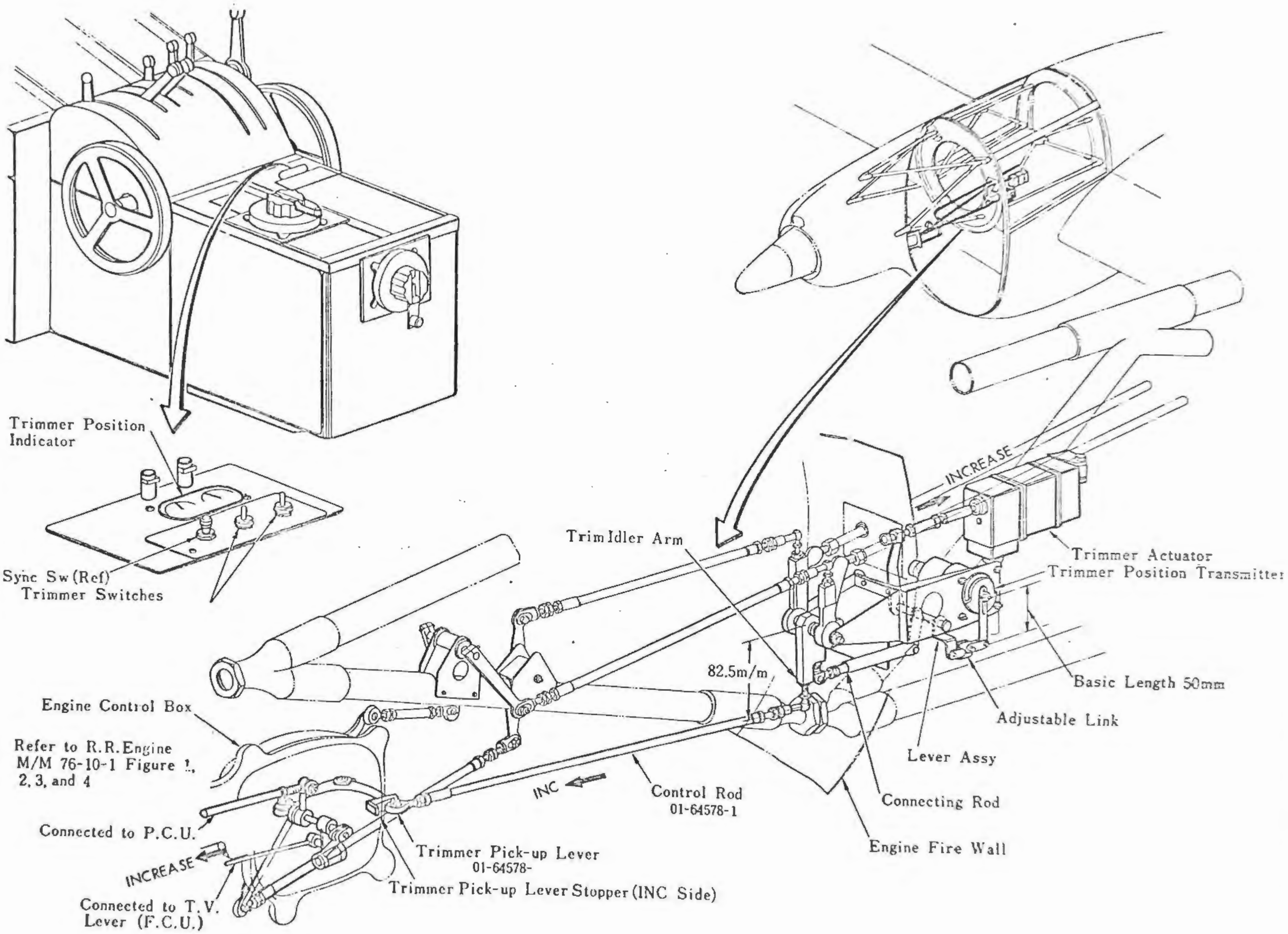
If the trimmer switch on the pedestal is turned to INC or DEC, the trimmer actuator on the engine side rotates while the switch is being depressed. The motor moves the plunger rectilinearly which is connected to a rod actuating the engine trimmer pickup lever.

(a) Structure of Trimmer Actuator

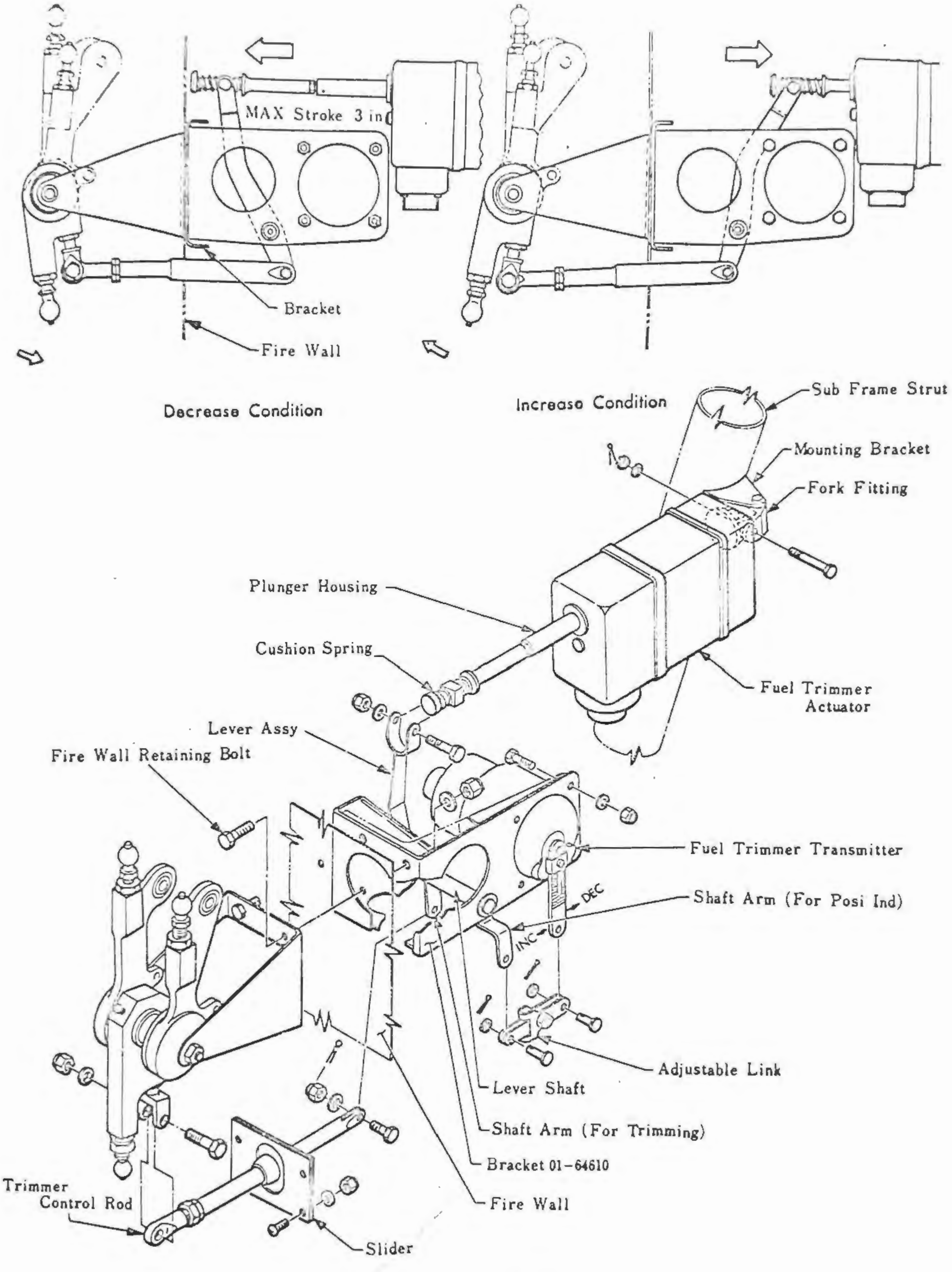
Inside the actuator is located a motor operating on 22 to 28 V DC. The motor rotation moves the screw jack rectilinearly through the reduction gears. The screw jack is located in the plunger housing, its rectilinear motion being the plunger stroke. The stroke is 3 in. at the maximum. Inside the actuator are provided two limit switches which stop the motor automatically if the plunger reaches its extreme ends. On the ends of the plunger are installed shock absorbing fittings with cushion springs to avoid damage to the actuator.

(b) Trimmer Position Transmitter (Fig. 4-30)

If the trimmer actuator moves, its actuating lever swings to the left and to the right. The lever, in turn, swings the sector gear plate to the left and to the right. Then, the pinion gear rotates. The arm rotates the turning assembly with the pin coupling.

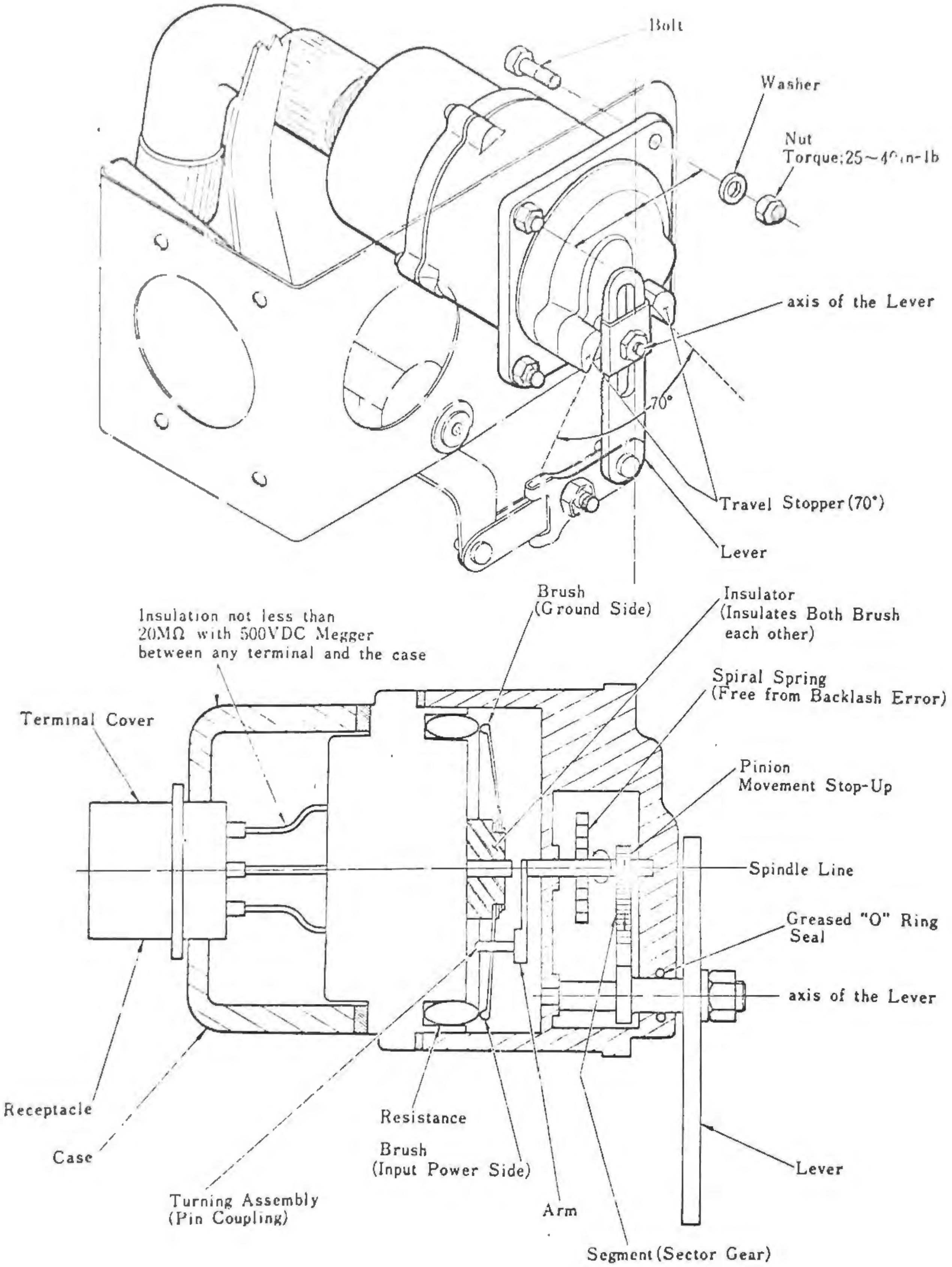


Fuel Trimmer Control System General View
Figure 4-28



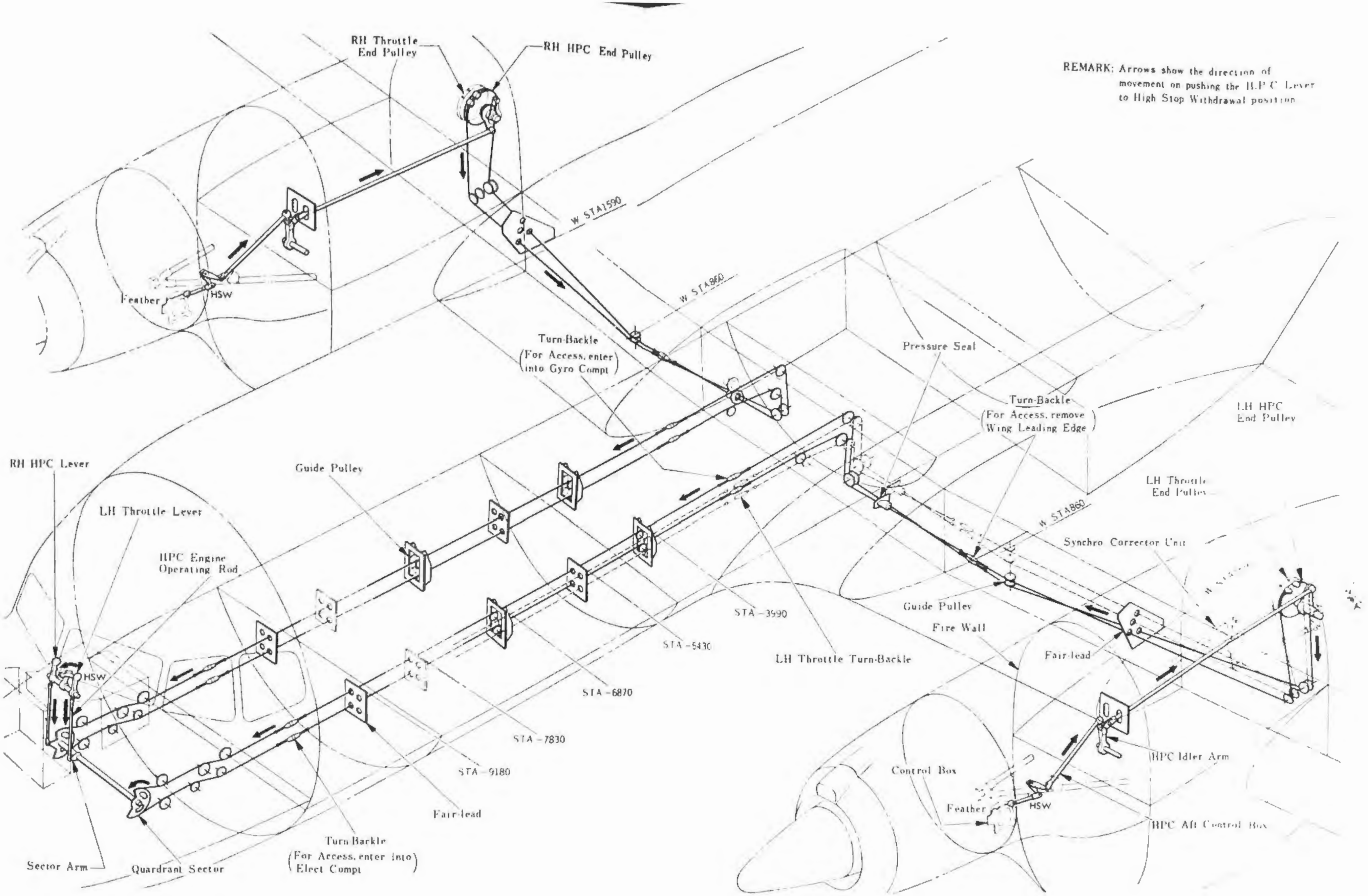
Fuel Trimmer Actuator & Transmitter

Figure 4-29



Fuel Trimmer Position Transmitte

Figure 4-30



REMARK: Arrows show the direction of movement on pushing the H.P.C Lever to High Stop Withdrawal position

HPC Lever Control System General View

Figure 4-31

4.8.7 H.P.C. Control System

(1) General

H.P.C. stands for the high pressure cock. This permits or shuts off the high pressure fuel supply to the engine fuel manifold located in the fuel control unit. This is manually controlled by a lever in the cockpit.

When the H.P.C. lever is located in the high stop withdrawal position, a mechanical circuit which withdraws the high stop is made manually by the feathering selector lever of the propeller control unit. If the electrical circuit is energized at the same time, the feathering motor rotates to feather the propeller.

This lever has the following four positions on the pedestal:

4 positions {
High Stop Withdrawal Position
Fuel ON "
Fuel OFF "
Feather "

The micro switch on the switch panel of the pedestal actuates the lever arm mechanically, depending on the lever positions.

(2) Composition of System (Fig. 4-31)

The system is actuated in the following sequence:

Lever → Lever Arm → Operating Rod → Sector → Cable → Control Rod → Engine H.P. Cock & Feathering Pickup Lever.

The quadrant sector of the center pedestal and the nacelle quadrant are connected with a cable in which are used three turnbuckles. The nacelle quadrant and the engine H.P. Cock & feathering pickup lever are connected with rods.

At the fuselage -- wing joint is used a pressure seal.

(3) Operation of H.P. Cock Lever

The normal position of the lever when the aircraft is stationary on the ground is "Fuel OFF."
As soon as the engine speed reaches 1200 to 1500 rpm at the engine starting, the lever must be moved to the high stop withdrawal at once.
If the starting failed within 30 sec., move the lever to "Fuel OFF" and place the start selector switch in "Safe."

4.8.8 Adjustment/Check of Power Plant Control System

(1) Adjustment of Throttle Control System

Tools for adjustment to be prepared

a. 01-96214
b. 01-96075-11, 01-96230-11, -21 and -60
c. 20 lb spring balance
d. Cable tension meter

A. Adjust the engine control linkage properly in accordance with the engine maintenance manual, M-Da10-YS.

B. Adjustment Zones

The throttle control system is divided into the following four zones: If adjustment of one part does not affect the others, readjustment of other parts is not necessary.

(A) Throttle lever -- quadrant sector below the pedestal

(B) Quadrant sector below the pedestal -- upper quadrant pulley on the spar on the forward side of the fire wall

(C) Upper quadrant pulley on the spar on the forward side of the fire wall -- idler lever on the forward side of the fire wall

(D) Idler lever on the forward side of the fire wall -- engine control box

C. Adjustment of Throttle Lever -- Quadrant Sector below Pedestal

NOTE: While the adjustment is made, keep the idler arm of the control rod joint disconnected from the rod.

(A) Disengage the gust lock, advance the throttle levers together and place the gust lock stopper in close contact with the low stop hook. Protrude the max stop bolt until it touches the low stop shaft. Retard the throttle slightly and protrude the stop bolt a little by rotating it by 1/4 turn.

Make sure that the mark on the side of the throttle lever is located slightly ahead of the blue mark (Fig. 4-20) on the disc in case of Fig. 4-23, A.

(B) Place the throttle torque tube below the pedestal in the max. position, adjust the length of the rod assembly connected to the throttle lever torque tube and tighten the check nut so that the rig pin, 01-96075-11 can be inserted into the throttle sector arm side rigging hole of the arm and the rig pin hole of the structure and be fixed and the mark on the side of the throttle lever can be brought in line with the red mark on the disc. (The position of the throttle lever is 5° before the position described in 8 (1) C (A).)

(C) After confirming that the requirement of 8 (1) C (A) is met by moving the throttle lever a few times, paint marking on the check nut of the rod assembly(this indicates slip and color and marking method are discretionary.).

(D) Holding the throttle lever in such a position that the mark on the side of the throttle lever is brought in line with the white mark on the disc, adjust the length of the throttle switch operating rod (Fig. 4-23) until the mark on the side of the box side marking of the throttle micro switch box is brought in line (Fig. 4-18), and, then tighten the check nut.

D. Adjustment of Quadrant Sector below the Pedestal -- Upper Quadrant Pulley on Forward Spar of Nacelle

(A) Insert the rig pin, 01-96075-11 into the arm of the throttle torque tube below the pedestal and the rig pin hole of the structure and fix it at the max. position.

(B) Insert the rig pin, 01-96230-11 into the upper quadrant pulley on the forward spar of the nacelle and the rig pin hole of the pulley bracket and fix it at the max. position (Fig. 4-32).

(C) Adjust the cable tension between the sector below the pedestal and the end pulley to the value as shown in Fig. 4-34.

(D) Remove the rig pin fixing the end pulley, make sure that both cable tensions are well balanced and put safety wire on the turnbuckles. Later, remove the rig pin fixing the sector located below the pedestal.

E. Adjustment of Upper Quadrant Pulley on Forward Spar of Nacelle

(A) Fix the end pulley at the max. position with a rig pin.

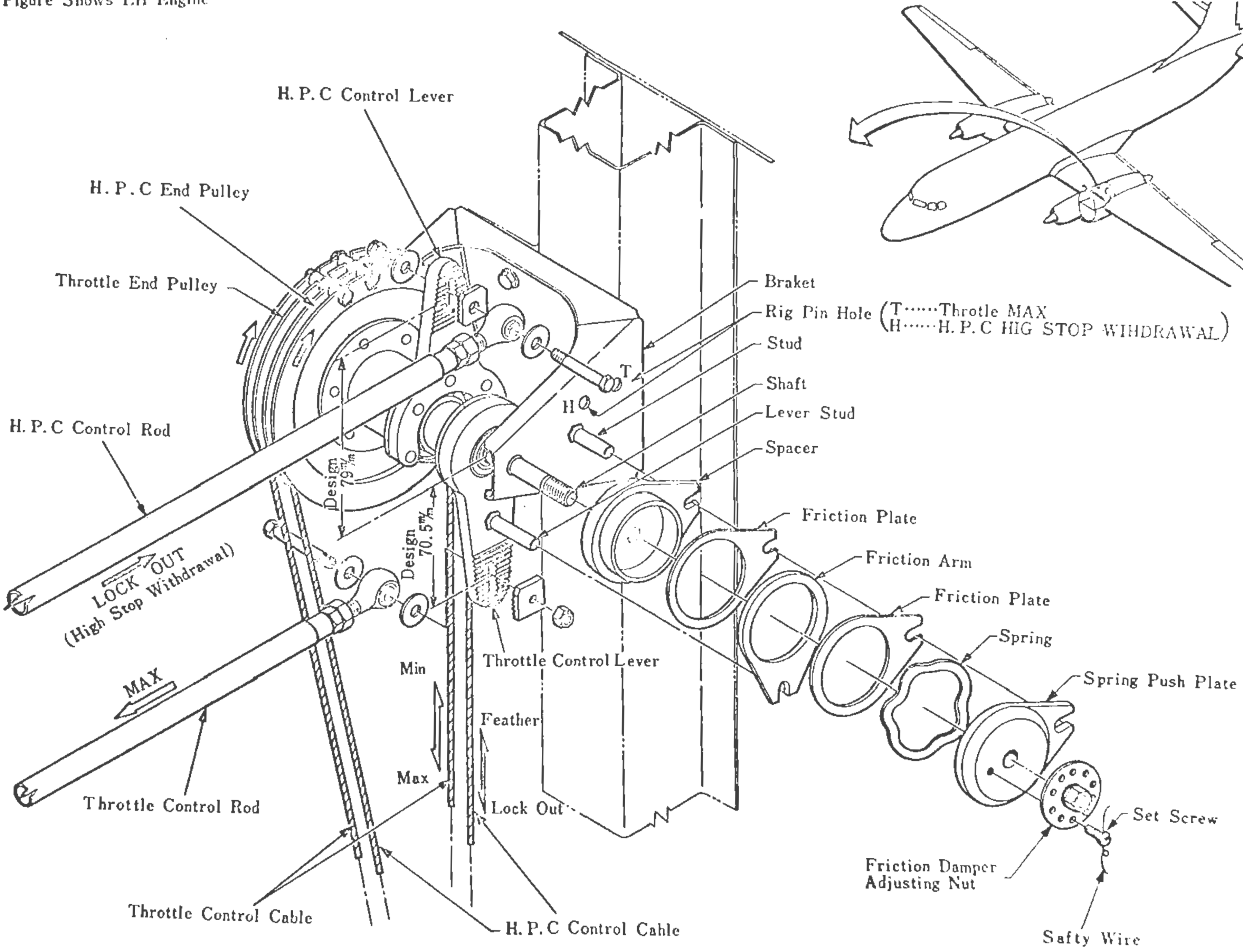
(B) Set the locking plate, 01-96214 on the propeller synchro corrector motor (SNC/22) and set the slot on the eccentric shaft of the corrector motor.

NOTE: The instruction of this sub-paragraph is applicable to the L.H. side only.

(C) Adjust the arm length of the end pulley to the design value (69.5 m/m) and adjust the length of the throttle control lever so that the propeller synchro arm assembly can be fixed, inserting the rig pin, 01-96230-21 into the rig pin hole of the propeller synchro arm and the rig pin hole of the corrector motor mounting pad assembly, and, then, tighten the check nut (Figs. 4-32 and 4-35).

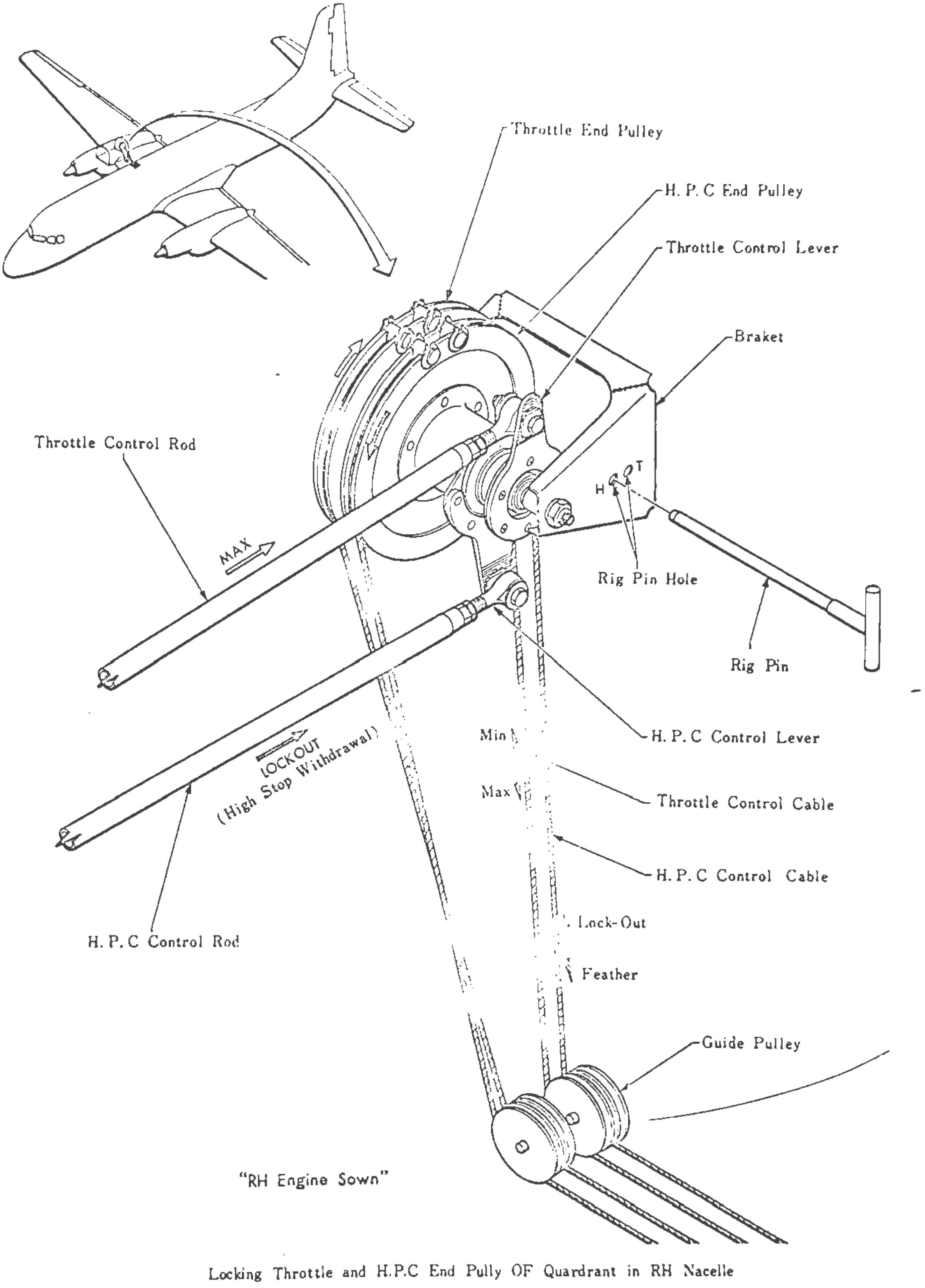
NOTE: This instruction is applicable to the L.H. side only.

"Figure Shows LH Engine"



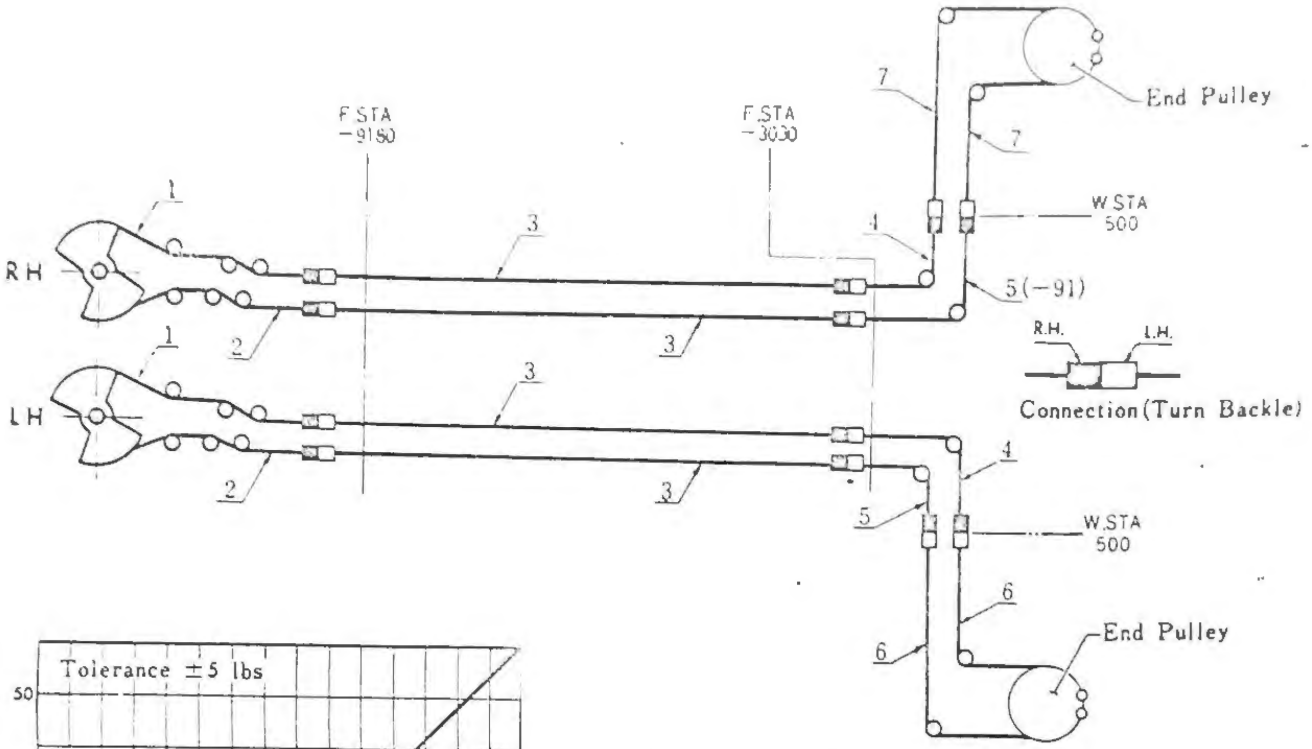
Locking Thrattle and H.P.C End Pully OF Quardrant in LH Nacelle

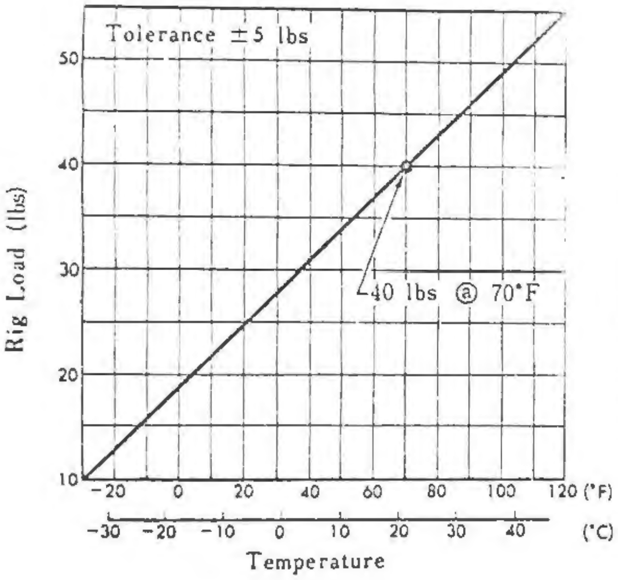
Figure 4-32



Locking Throttle and H.P.C End Pully OF Quadrant in RH Nacelle

Figure 4-33

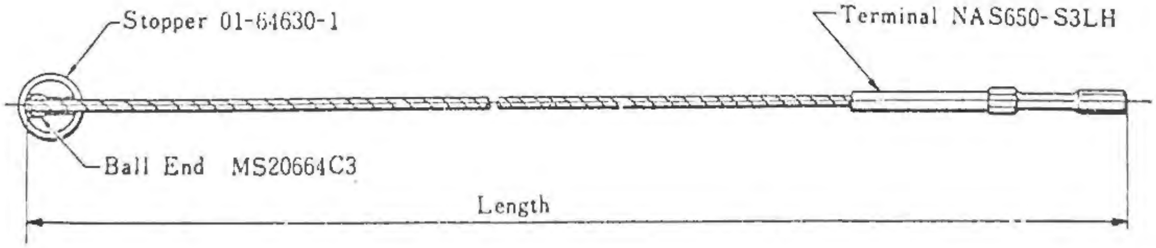




Initial Cable Tension

	Cable Assy Parts Number	Fitting		Length mm
1	01-64210-61	AN664-3	AN669L3RH	1,367
2	01-64210-71	AN664-3	↕	1,390
3	01-64209-51	AN669L3LH		6,400
4	01-64209-61	↕		2,597
5	01-64209-71	AN669L3LH	AN669L3RH	2,512
*6	01-64629-11	See Detail A		3,400
*7	01-64629-21	See Detail A		2,700

Note: As shown in detail A, the stopper 01-64630-1 shall be attached to one end of cable assembly marked with*



Detail A

Cable Chart (Throttle)

Figure 4-34

(D) Insert the rig pin 01-96230-61 into the rig pin holes of the throttle idler arm and the idler bracket on the forward side of the fire wall and adjust the length of the throttle rod so that the idler lever arm can be fixed at the max. position. And, then, tighten the check nut (Fig. 4-37).

NOTE: This instruction is applicable to the L.H. side only.

(E) Insert the rig pin, 01-96230-61 into the rig pin holes of the throttle idler arm assembly and the bracket assembly on the forward side of the fire wall, set the length of the arm of the end pulley to the design value of 61.0 mm and adjust the length of the throttle control rod so that the idler lever arm can be fixed at the max. position. And, then, tighten the check nut (Fig. 4-33).

NOTE: This instruction is applicable to the R.H. side only.

F. Adjustment of Idler Lever -- Engine Control Box on Forward Side of Fire Wall

(A) Set the length of the connecting arm for the throttle idler arm and the ball end on the forward side of the fire wall to the design value of 125.0 mm and, then, tighten the check nut (Fig. 4-40).

NOTE: Adjust the position of the indicator plate of the throttle idler arm so that its pointer is brought in line with the max. position.

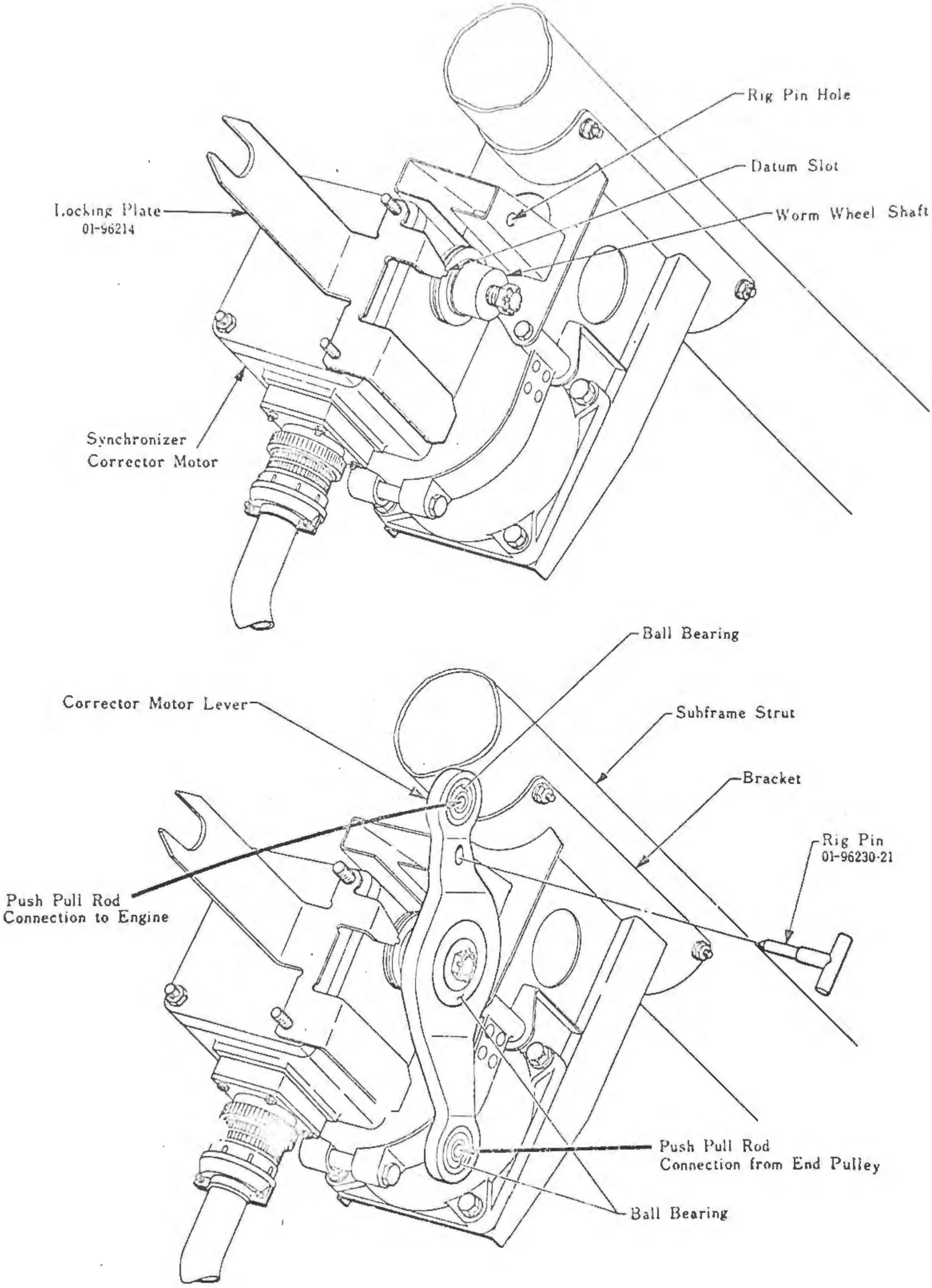
(B) Adjust the length of the throttle rod connecting the idler arm on the forward side of the fire wall and the arm located before the engine control box, and connect the arm located before the engine control box and the engine control box pickup lever to place them in positive contact with the max. stopper of the engine control box. Accomplish adjustment so that the center line of the throttle arm is brought in line approximately with the center line of the supporting point of the arm bracket.

(C) Remove all the rig pins and operate the throttle lever so that the engine pickup lever is in contact with the min. stopper of the engine control box. Make sure that the gap between the adjustable bolt installed on the throttle lever on the pedestal and the stopper is 3.5 mm.
It is desirable that under the above mentioned conditions, the mark on the side of the throttle lever is lined up with the white mark on the disc (Fig. 4-20).

NOTE: Accomplish adjustment so that the position of the min. indicator plate of the firewall idler lever is lined up with the pointer when the engine pickup lever is in contact with the min. stopper of the engine control box.

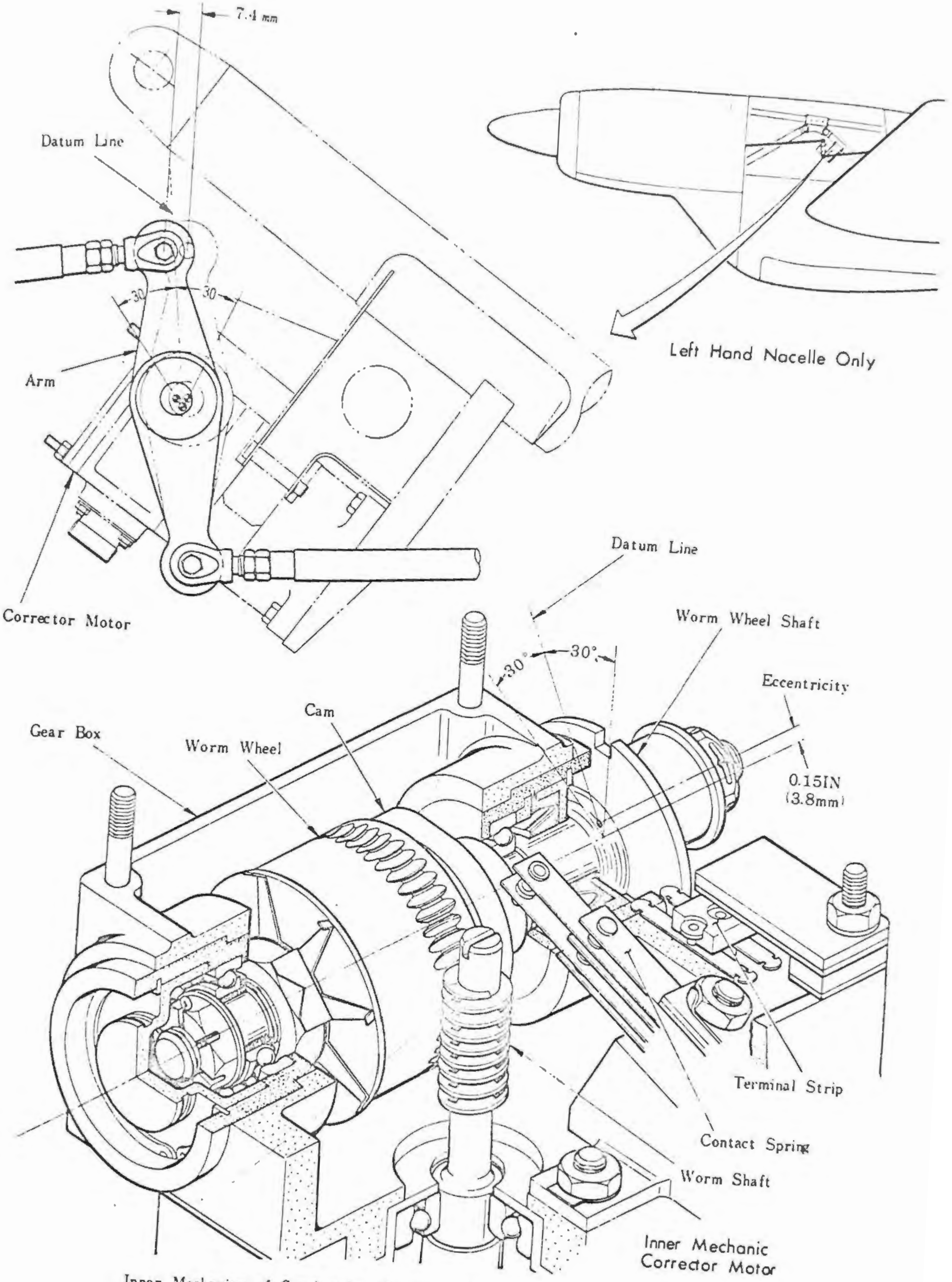
(D) Adjustment of Friction Damper

NOTE: This instruction is applicable to the L.H. side only.

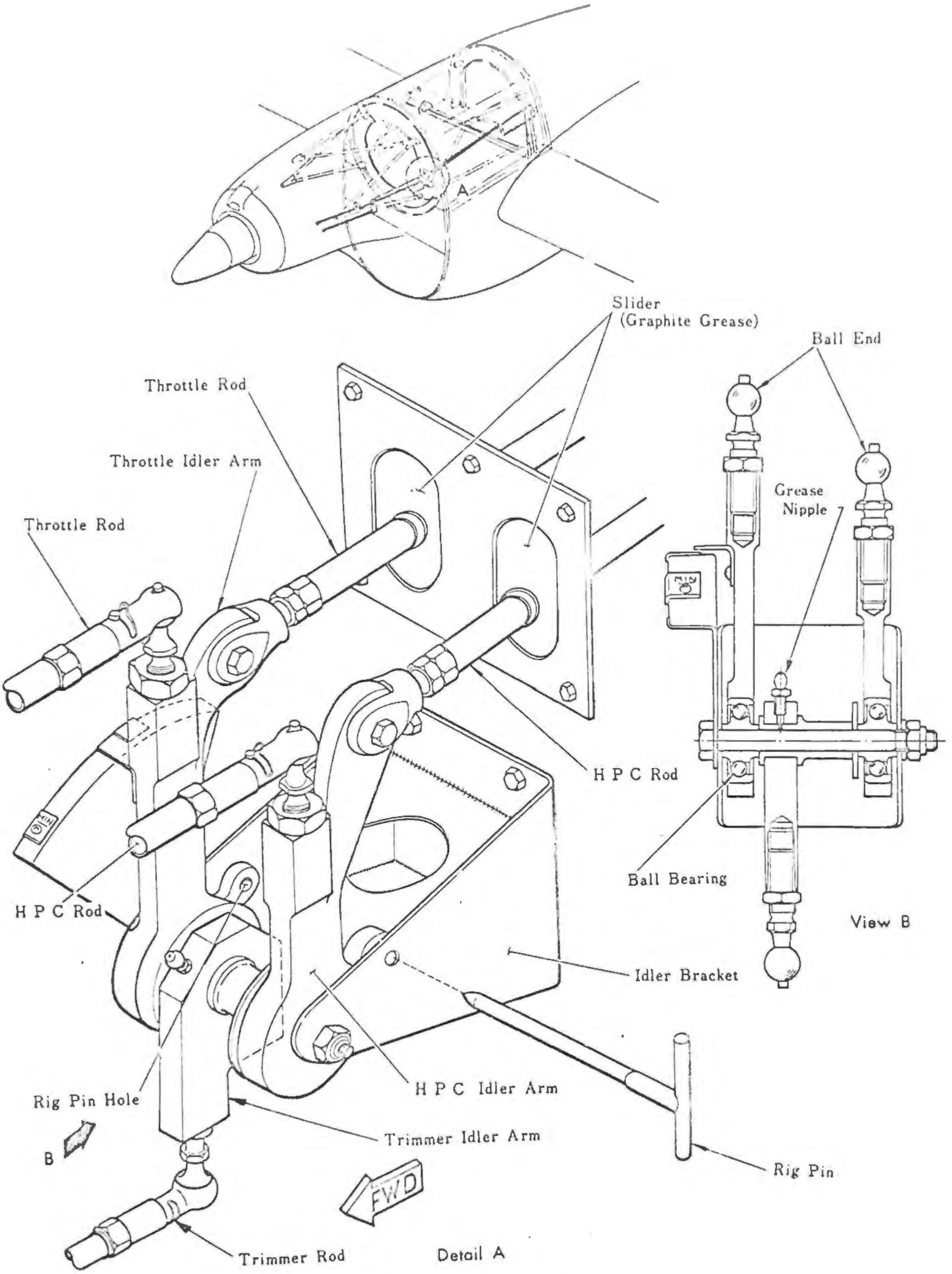


Locking-Synchronizer Corrector Motor

Figure 4-35



Inner Mechanism of Synchronizer Corrector Motor and Opereation Diagram
Figure 4-36



Idler Lever Assembly on Fire wall

Figure 4-37

a. Disconnect the joint of the throttle control rod connected to the corrector motor arm and the throttle control lever.

b. Tighten the friction damper adjusting nut so that the end pulley arm begins to move at the torque value of 30 to 45 in.lb. (Fig. 4-32).

(E) Make sure that the throttle can be fixed at the max. position, that the mark on the side of the throttle lever is lined up with the red mark of the disc and that the mark pointer of the idler lever on the engine fire wall indicates the max. position of the throttle position indicator.

(F) Check the control force of the throttle lever at the following points, make sure that it is less than 7.5 lb and record the control force measured.

NOTE: During this operation, maintain the low stop lever in the flight position.

a. Advance the throttle lever further ahead of the position in which the mark on the side of the throttle lever is lined up with the red mark on the disc to align the side mark to the blue mark on the disc. The control force must be 200 to 250 % of the "PUSH" control force mentioned in 8(1) F(F).

b. Retard the throttle lever until it hits the adjusting bolt stopper 3.5mm away from the throttle lever when it is in contact with the engine side min. stopper. Then, the control force must be 200 to 250 % of "PULL" control force described in 8(1) F(F).

NOTE: Make sure that no check nut is loose.

(2) Adjustment of H.P.C. Control System

Tools to be prepared.

(a) Rig pin, 01-96075-1, 01-96230-11 and -61

(b) Cable tension meter

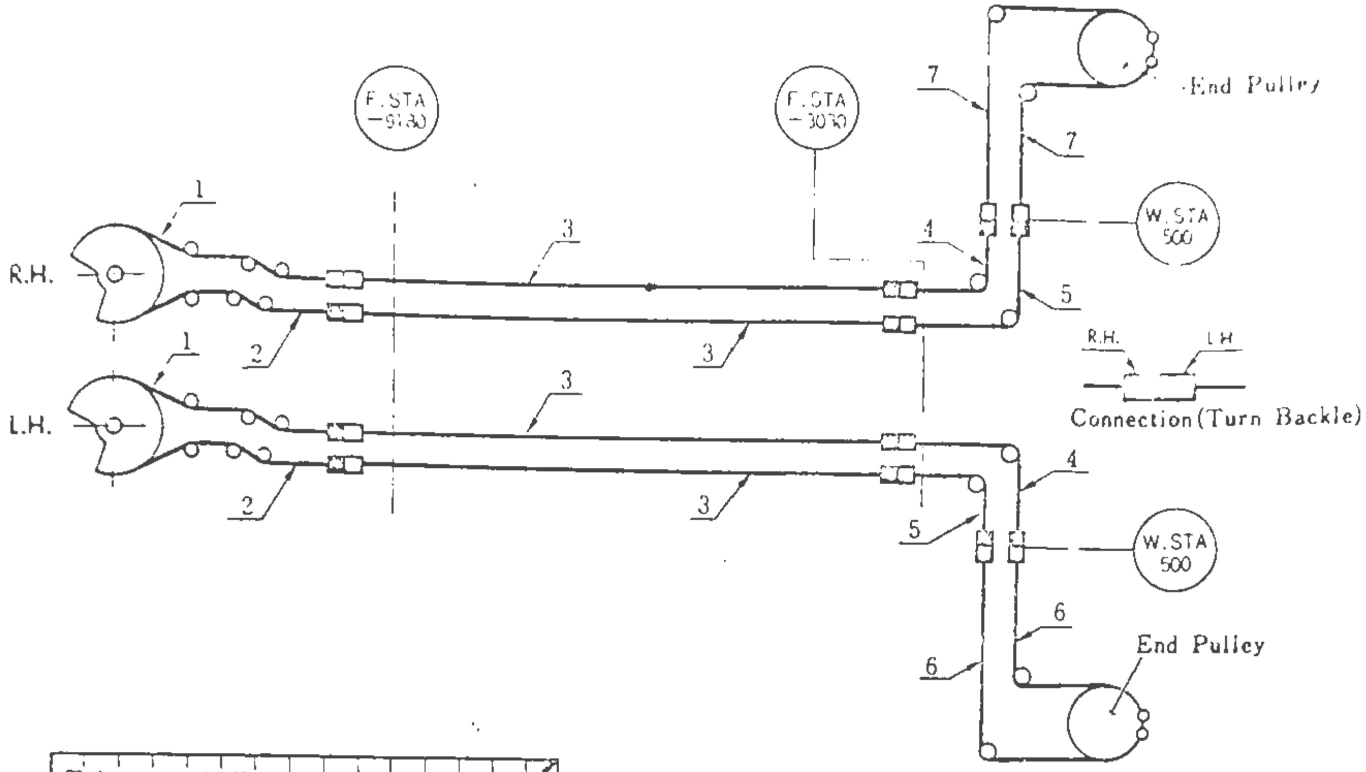
A. Adjustment of H.P.C. Lever -- Quadrant Sector below Pedestal

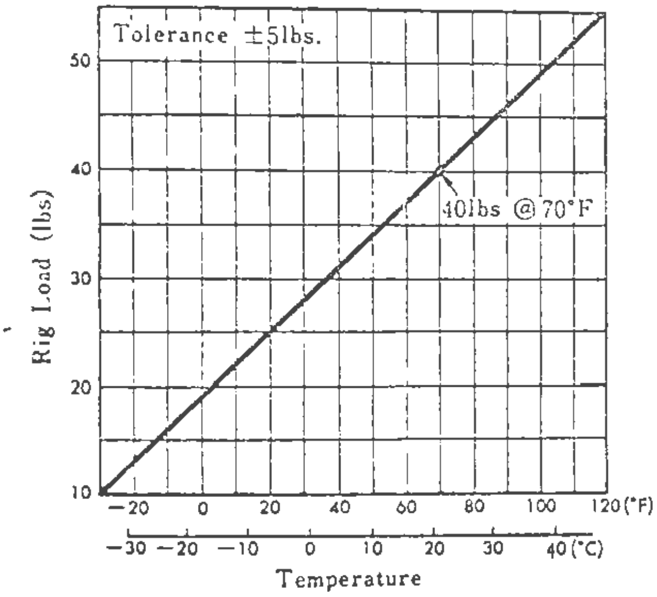
(A) Place the H.P.C. lever in the high stop withdrawal position.

(B) Insert the rig pin, 01-96075-1 into the rig pin hole of the arm or the sector so that the H.P.C. torque tube below the pedestal or the sector is placed in the high stop withdrawal position to fix the sector.

a. Adjust the length of the H.P.C. operating rod so that the conditions of 8(2) A (A) and (B) are attained simultaneously.

b. Rotate the rod assembly adjusted in 8(2) A(a) by 0.6 turns, tighten the check nut fixing the rod end and paint marking

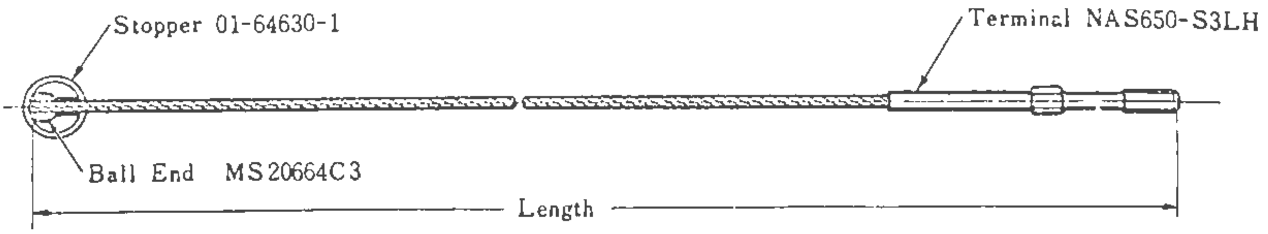




Initial Cable Tension

	Cable Assy Parts Number	Fittings		Length mm
1	01-64210-81	AN664-3	AN669L3RH	1,238
2	01-64210-91	AN664-3	↓	1,254
3	01-64209-51	AN669L3LH		6,400
4	01-64209-81	↓		2,714
5	01-64209-91	AN669L3LH	AN669L3RH	2,629
*6	01-64629-11	See Detail A		3,400
*7	01-64629-21	See Detail A		2,700

Note: As shown in detail A, the stopper 01-64630-1 shall be attached to one end of cable assembly marked with*



Detail A

Cable Chart (H.P.C.)

Figure 4-38

on the check nut. (This indicates slipping. Color and marking method are discretionary).

c. Remove the rig pin, pull the H.P.C. lever, adjust the lengths of the switch rod and the rod end so that the side mark of the H.P.C. switch box is lined up while the lever guide pin is in the rear groove of the high pressure guide and, then, tighten the check nut.

d. Move the H.P.C. lever several times to make sure that the requirement of 8(2) A(c) is satisfied and paint mark on the check nut of the switch rod. Make sure that the rod assembly is normal by checking the mark painted in 8(2) A(b).

B. Adjustment of Quadrant Sector below Pedestal -- Nacelle Quadrant Pulley (Fig. 4-22)

NOTE: During the operation mentioned here, any connection of the control tube in the nacelle must be kept disconnected.

(A) Fix the torque tube assembly below the pedestal or the sector assembly in the high stop withdrawal position with a rig pin.

(B) Fix the upper quadrant pulley on the forward spar in the nacelle in the high stop withdrawal position with the rig pin, 01-96230-11.

(C) Adjust the tension of the cable between the sector below the pedestal and the end pulley to the value shown in Fig. 4-38.

(D) Remove the rig pin fixing the end pulley, make sure that the tensions of both cables are uniform and lock the turnbuckles with safety wire. Then, remove the rig pin fixing the sector below the pedestal.

C. Adjustment of End Pulley -- Engine Control Box

(A) Disconnect one end of the control rod connected to the lever assembly located before the engine control box.

(B) Fix the end pulley in the high stop withdrawal position with a rig pin.

(C) Adjust the lengths of the H.P.C. control rod and the H.P.C. control lever which connect the idler arm in front of the fire wall and the end pulley so that the idler arm can be fixed in the high stop withdrawal position with the rig pin, 01-96230-61 and that the length of the arm connected to the end pulley can be equal to the design value 79.0m/m. And, then, tighten the check nut. (L.H. Fig. 4-32)

NOTE: The procedures described here are applicable to the L.H. as well as to the R.H.
For R.H. see Fig. 4-34.

(D) Adjust the length of the arm connecting the idler arm in front of the fire wall and the ball end to the design value of 100.0 m/m and tighten the check nut. (Fig. 4-39)

(E) Fix the idler arm in front of the fire wall in the high stop withdrawal position with a rig pin.

(F) Adjust the lengths of the idler arm in front of the fire wall and the H.P.C. rod located before the engine control box and the length of the rod connecting the lever located before the engine control box and the engine control box pickup lever so that the engine control box pickup lever comes in positive contact with the L.O. stopper and, then, tighten the check nuts.

(G) Remove all the rig pins and place the H.P.C. lever of the pedestal in the feather position. Then, the engine control box pickup lever must be in positive contact with the F stopper. When the H.P.C. lever is placed in the high stop withdrawal position, the pickup lever must be in contact with the L.O. stopper positively.
After making sure that this requirement is met by moving the H.P.C. lever several times, paint the slip mark on the check nuts of the control rods in the nacelle.

D. Adjustment of High Pressure Guide Adjusting Plate Position

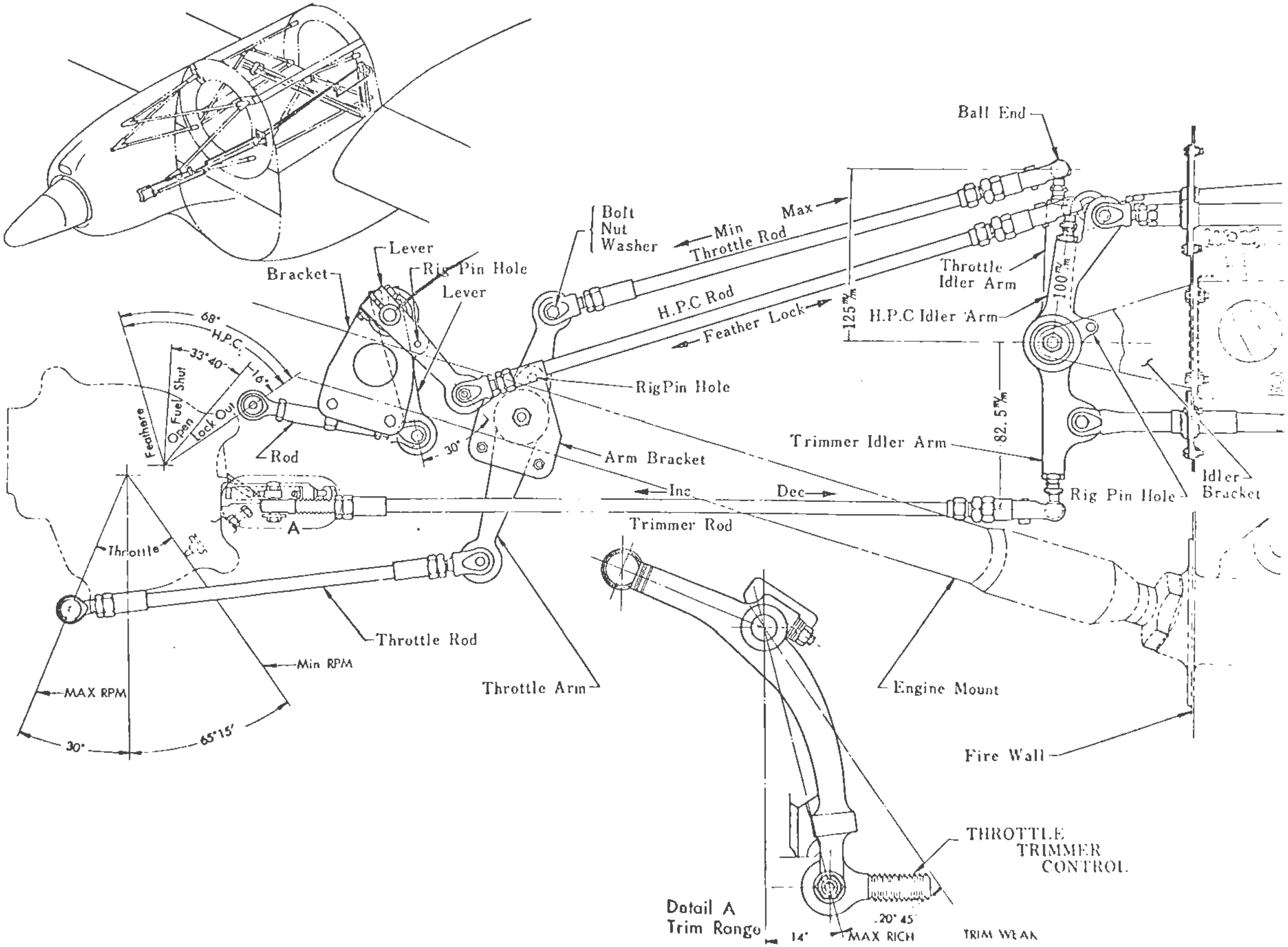
(A) Fix the ON position of the adjusting plate on the pedestal so that the pickup lever of the engine control box is lined up with "O" mark of the engine control box when the H.P.C. lever is pushed to the "ON" position and when it is pulled to the "ON" position.

NOTE: If the "O" mark of the engine control box is not clear, make sure that the lever mark of the engine F.C.U. is within the "Open" range and that the feathering selector lever mark of the engine P.C.U. is within the "RUN AUTO" range, instead of checking the alignment of "O" mark of the pickup lever.

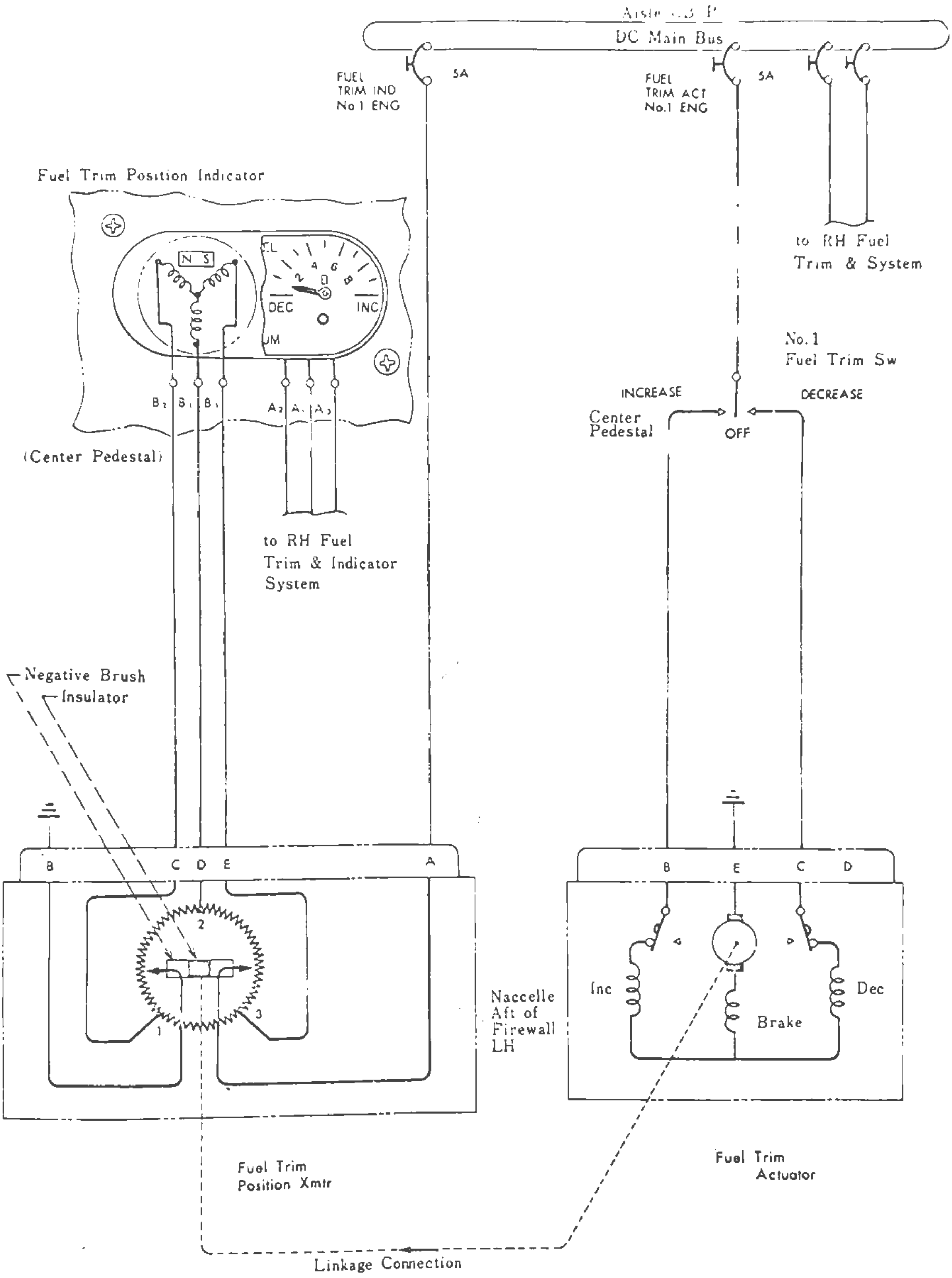
(B) Adjust and fix the "OFF" position of the adjusting plate on the pedestal so that the pickup lever of the engine control box is lined up with the "S" mark of the engine control box when the H.P.C. lever is pushed to the "OFF" position and when it is pulled to the "OFF" position.

NOTE: If the "S" mark of the engine control box is not clear, make sure that the lever mark of the engine F.C.U. is within the "Shut" range and that the feathering selector lever mark of the engine P.C.U. is within the "UF" range, instead of checking the alignment of "S" mark of the pickup lever.

E. Check the control force of the H.P.C. lever at the following points and make sure that the control force is less than 7.5 lb.:



Push Pull Rod System in Engine Bay
Figure 4-39



Fuel Trim & Indication System Schematic
Figure 4-40

4.8.9 Emergency Shut Down System (Fig. 4-41)

(1) The emergency shut down system shuts down fuel and hydraulic oil supply to the engines and makes electrical circuits preliminarily for discharging of fire extinguishing agent.

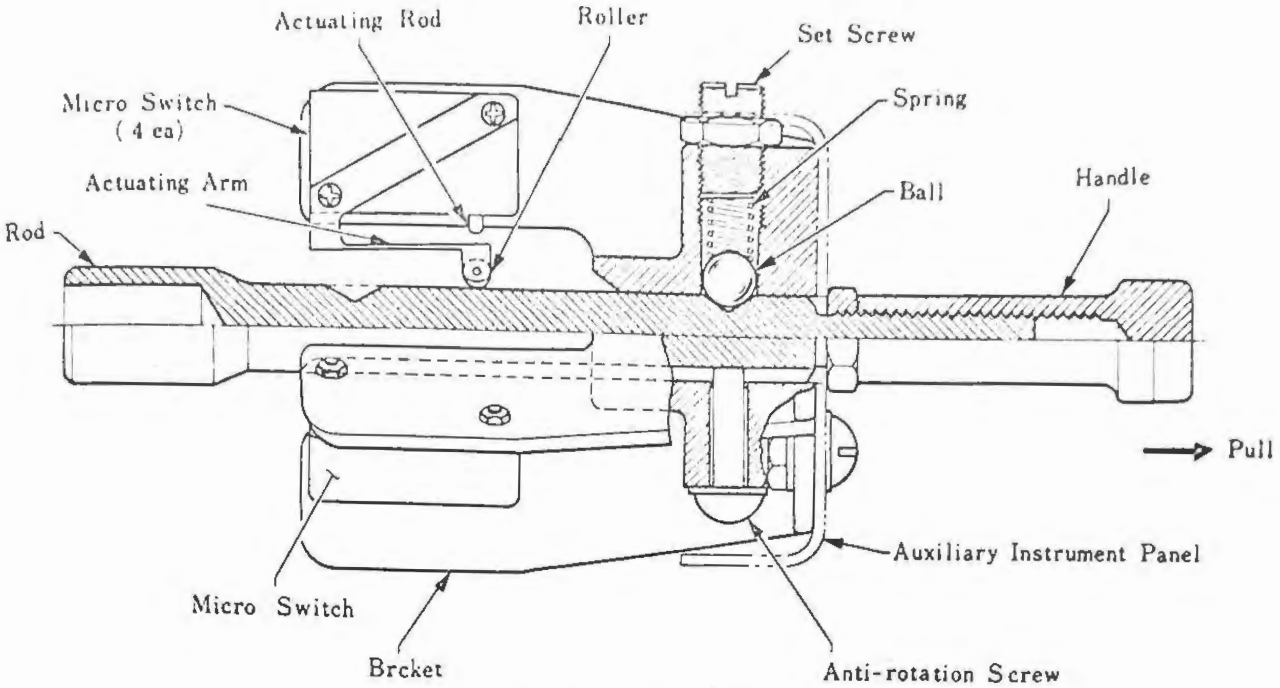
This system is not related to any other function.
The emergency shut off handles are provided 1 ea. for the engines on the auxiliary panel in the cockpit. If the handle is pulled, a micro switch is energized to make the circuit.

Once the circuit is made, the following units come into action:

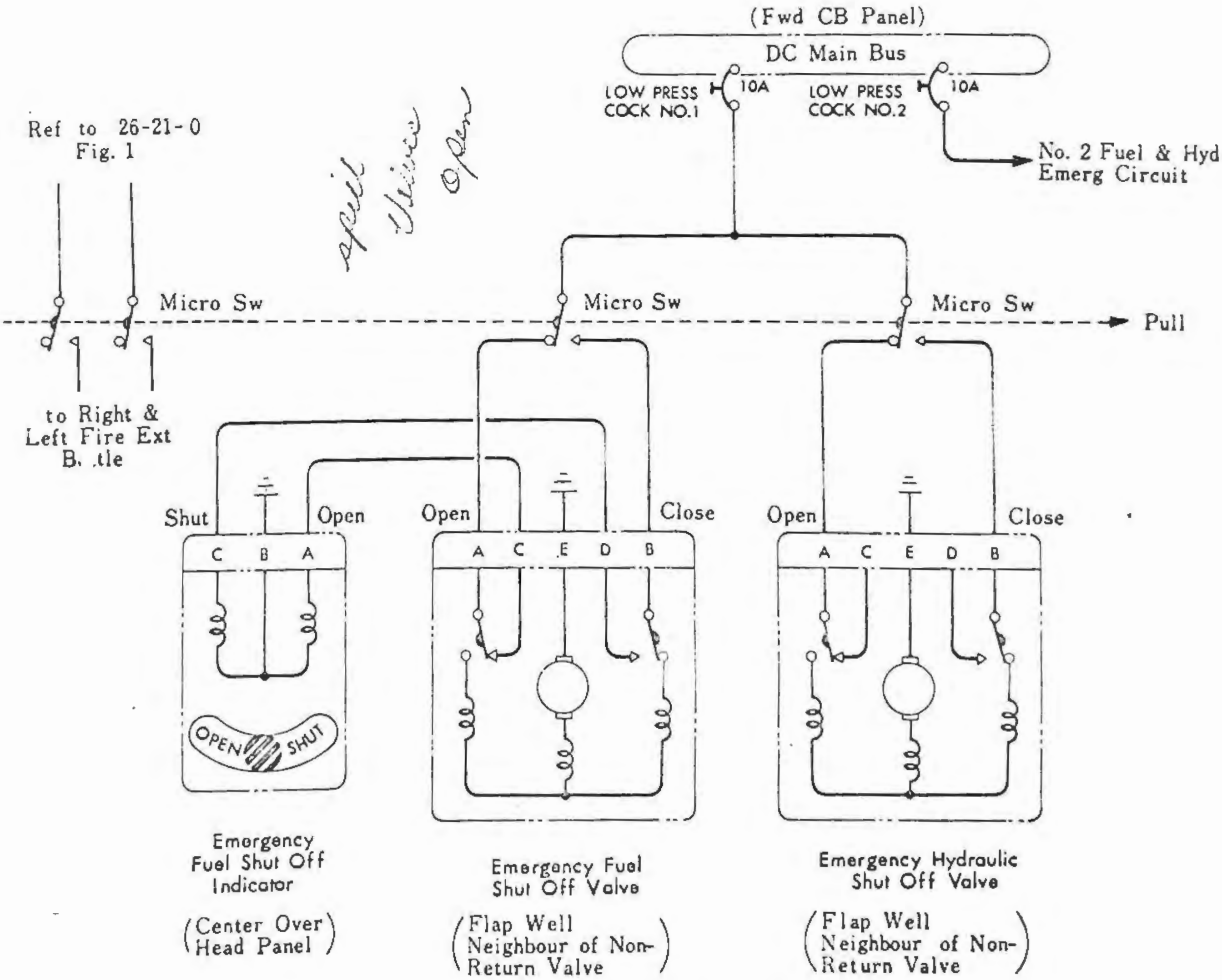
Emergency Fuel Shut Off Valve
Emergency Hydraulic Oil Shut Off Valve.

If the handle is pulled, the emergency fuel shut off indicator indicates "SHUT."

As a result, the fire extinguishing circuit is ready to discharge the fire extinguishing agent.



Emergency Shut off Handle


(Fwd CB Panel)
DC Main Bus
LOW PRESS COCK NO.1
10A
LOW PRESS COCK NO.2
10A
No. 2 Fuel & Hyd Emerg Circuit
Ref to 26-21-0 Fig. 1
April
Open
Micro Sw
Micro Sw
Micro Sw
Pull
to Right & Left Fire Ext B. .tle
Shut
Open
Open
Close
Open
Close
C B A
A C E D B
A C E D B
OPEN SHUT
Emergency Fuel Shut Off Indicator
(Center Over Head Panel)
Emergency Fuel Shut Off Valve
(Flap Well Neighbour of Non-Return Valve)
Emergency Hydraulic Shut Off Valve
(Flap Well Neighbour of Non-Return Valve)

Emergency Shut off & Indicating Schem

Figure 4-41

4.9 Adjustment and Testing of Power Plant

4.9.1 General

4.9.1.1 Engine Serviceability Check

(1) After a new engine is installed or an engine is replaced.

(2) After a new propeller is installed or a propeller is replaced.

(3) After F.C.U., P.C.U., W/M unit or other units are replaced or after the engine control system is adjusted.

4.9.1.2 Other Aircraft Serviceability Check

4.9.1.3 In Case of Trouble Shooting

(1) When the flight performance is not satisfactory.

(2) When the engine starting is abnormal.

(3) When the engine speed is abnormal.

(4) When the torque pressure is abnormal.

(5) When rough running is suspected.

(6) When the oil system is malfunctioning.

(7) When the propeller system is malfunctioning.

(8) Others.

4.9.2 Ground Run-up Procedures

4.9.2.1 Environment of Run-up Site

(1) Be sure that the ground around the aircraft, especially the propellers is clean, and

(2) that the aircraft is located far enough from the other aircraft.

4.9.2.2 Preparation prior to Starting

(1) The aircraft against the wind within ± 30°.

(2) Assignment of required personnel

(3) Preparation of ground fire extinguishing equipment

(4) Desirable ground power unit

a. Maximum peak capacity: 2000A, 5 sec.
b. 1400A, 1 min.

(5) When the engine speed is reduced from 15,000 rpm to 14,500 rpm, move the throttle lever slowly taking more than 5 sec.

NOTE: If the throttle lever is abruptly retarded, T.G.T. may overshoot. In order to avoid overheating which is likely to take place since the propeller may not be at the ground fine pitch, close the H.P. cock lever immediately.

(6) If the T.G.T. exceeds the specified limits during the engine run, close the H.P. cock lever (Fuel OFF) immediately.

(7) Do not open-up the throttle lever while the engine oil temperature is below -15°C.

(8) Set the fuel trimmer to the outside air temperature.

a. Move the trimmer gradually (especially when it is moved from DECREASE to INCREASE.)

b. Pay attention to the variation of the T.G.T. whenever the fuel trimmer is operated.

(9) Keep the H.P. cock lever in the high stop withdrawal position (H.S.W.D.) during all the ground running.

(10) Keep the gust lock lever in the lock position (the low stop lever in GROUND position) unless specified otherwise.

NOTE: Be on the alert especially when the low stop lever is moved to the flight position while the gust lock lever is in the unlock position.
In such a case, pitch coarsening will take place, varying the engine speed and the T.G.T. is likely to overshoot. Therefore, this abnormal condition calls for special attention.

4.9.3 Operating Limitation for Power Plant

4.9.3.1 Maximum Ambient Temperature ISA + 30°C

4.9.3.2 The engine operating limitation is as follows:

Condition	Engine speed rpm	Max. T.G.T. °C	Allowable max. duration
Starting	-	930	Momentary
Ground Idling	* 8000 ~ 8500	600	Unlimited
Approach Minimum	11,000	-	Unlimited
Other Conditions	less than 12,500 12,500 ~ 13,000 13,000 ~ 14,200 14,200 ~ 15,000	735 770 800 820	Unlimited
Maximum Continuous	15,000	890	Unlimited
Take-off			
With water methanol injection	15,000	890	5 min.
Without water methanol injection	15,000	865	
Overspeed	16,500	-	20 sec.

* The ground idling condition with the fuel trimmer at the maximum position at Static Sea Level, standard atmospheric conditions is determined by the fuel flow of 43.5 ± 1 Imp. Gal/hour (340 ± 6.5 lb/hr).

4.9.3.3 Oil Temperature and Oil Pressure

(1) Oil Inlet Temperature

a. Maximum	120°C
b. Minimum at starting	-30°
c. Minimum for throttle opening up	-15°C

(2) Oil Pressure

Minimum pressure at 12,000 rpm
13.5 psi at 55°C, and 12 psi at 115°C. The pressure between these two varies linearly in proportion to the temperature change. (more than 12 psi at 115°C to 120°C.)

4.9.3.4 In case of T.G.T. Overshoot

(1) If overheating takes place while the engine is running in the normal speed range, it is not necessary to remove the engine unless the T.G.T. exceeds the following limitation:

950°C for 5 sec. --- only for momentary rise.

4.9.5.2 T.G.T. Correction by Atmospheric Conditions

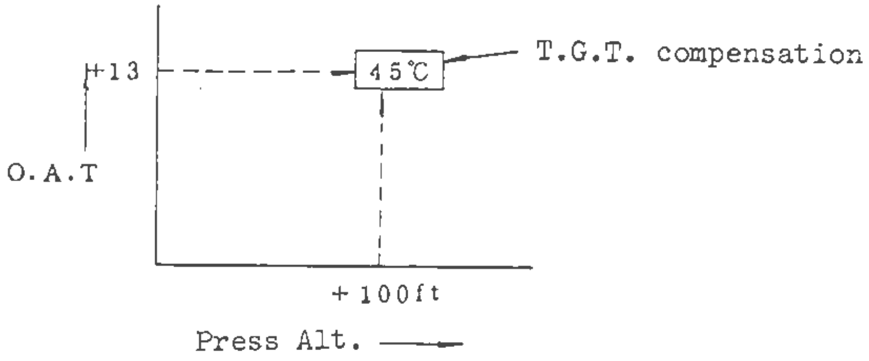
(1) Check the engine data.

(2) Based on O.A.T. and the pressure altitude at the location and the time, amount of compensation, using Figs. 4-43 and 4-44.

(Example)

Engine data	Max. T.G.T.	845°C
	Min. T.G.T.	815°C
Outside air temperature (O.A.T.)	+13°C	
Pressure altitude	29.83 Hg.in = + 85 ft ≒ 100 ft	

From T.G.T. corrections at 15,000 rpm (Graphical) Fig. 4-43
T.G.T. corrections at 15,000 rpm (Tabular) Fig. 4-44



(3) The amount of correction is obtained by subtracting the max. T.G.T. compensation calculated from the above table from the T.G.T. in the log book.

That is to say,

(Max. T.G.T. Data) - (Compensation) = Correction
(Min. T.G.T. Data) - (Compensation) = Correction

(Example)

Max. T.G.T. Correction = 845°C - 4.5°C = 840.5°C ≒ 841°C
Min. T.G.T. Correction = 815°C - 4.5°C = 810.5°C ≒ 811°C

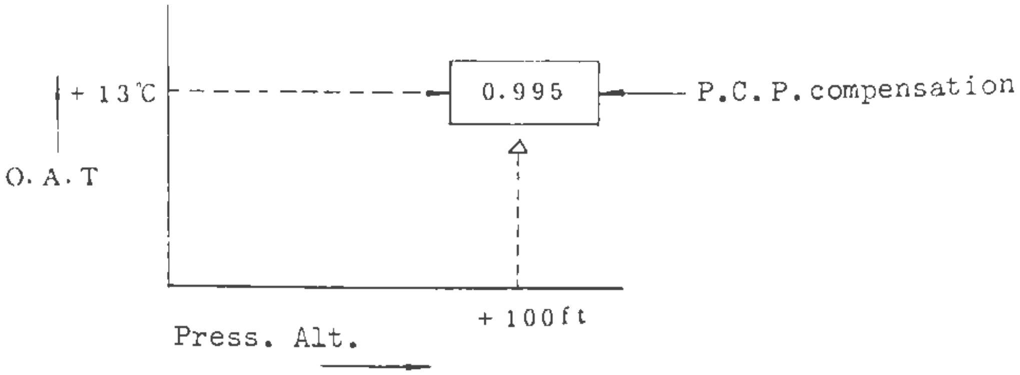
4.9.5.3 Engine Power Check Pressure (E.P.C.P.) Correction by Atmospheric Conditions

(1) Check the engine log book or the data plate.

(2) Based on O.A.T. and the pressure altitude at the location and the time, obtain the amount of compensation from the "correction to power check pressure" Fig. 4-45.

(Example)

Engine data P.C.P. 345 psi
Outside air temperature (O.A.T.) +13°C
Pressure altitude 29.83 $^{Hg.in.}$ = + 85^{ft} ≒ 100^{ft}



(3) The amount of correction is obtained by multiplying the P.C.P. of the engine data by the P.C.P. compensation obtained from Fig. 4-45.

(Example)

Engine Data E.P.C.P. 345 psi
Outside air temperature (O.A.T.) +13°C
Pressure altitude 29.83 $^{Hg.in.}$= + 85^{ft} ≒ 100^{ft}
P.C.P. compensation 0.995
Corrected E.P.C.P. = (Engine data plate P.C.P.) x (P.C.P. compensation) = 345psi x 0.995 = 342.27 psi
≒ 342 psi

NOTE: The correction value below the decimal point is rounded to an integer, by counting fractions of .5 a whole number and disregarding the rest.

4.9.5.4 Water Methanol Check Pressure Correction by Atmospheric Conditions

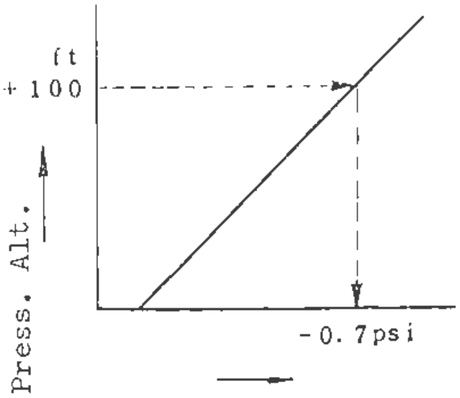
(1) Check the water methanol check pressure (W.M.C.P.) of the engine data plate.

(2) Based on the pressure altitude at the location, find the W.M.C.P. from the W.M.C.P, Fig. 4-48.

(Example)

Engine data: W.M.C.P. 410 psi
Pressure altitude: 29.83Hg.in. = + 85ft ≒ 100ft

From "Correction to W.M.C.P. for altitude" Fig. 4-48,



Corrections to be applied to data plate W.M.C.P-psi

(3) Add the W.M.C.P. compensation obtained in the above (2) to the W.M.C.P. of the engine data plate.

(Example)

Engine data: W.M.C.P. 410 psi
Pressure altitude: + 100ft
W.M.C.P. compensation: -0.7psi

W.M.C.P. correction = (Engine data plate W.M.C.P.) + (W.M.C.P. compensation)
= (410) + (-0.7 psi) = 409.3 psi ≒ 409 psi

4.9.5.5 Determination of Fuel Datum Position

Table in Figs. 4-46 and 4-47 are used to determine the fuel datum position, based on the outside air temperature and the pressure altitude.

Multiply engine power check pressure by factor

PREVAILING AIR TEMPERATURE - °C.	-1000	-500	-250	0	500	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
+45	.765	.752	.746	740	.726	.713	.685	.655	.629	.608					
+40	.805	.792	.783	.776	.764	.751	.720	.692	.666	.642	.611				
+35	.845	.831	.824	.816	.802	.790	.758	.731	.704	.679	.648	.625			
+30	.887	.873	.865	.858	.842	.829	.796	.770	.741	.715	.684	.660	.632		
+25	.933	.916	.908	.902	.885	.871	.837	.810	.782	.752	.720	.695	.666	.642	.615
+20	.981	.965	.955	.948	.931	.913	.880	.850	.823	.791	.760	.731	.702	.676	.648
+15	1.015	1.008	1.004	1.00	.981	.960	.925	.893	.863	.830	.798	.768	.737	.710	.682
+10	1.008	1.001	1.00	.995	.988	.980	.965	.938	.905	.870	.837	.806	.775	.745	.716
+5	1.002	.995	.992	.988	.981	.975	.960	.945	.930	.912	.880	.845	.814	.784	.751
0	.993	.988	.985	.980	.975	.968	.955	.941	.926	.910	.895	.880	.855	.823	.790
-5	.985	.979	.975	.971	.966	.960	.946	.933	.920	.905	.892	.877	.862	.846	.830
-10	.975	.970	.966	.963	.958	.952	.938	.925	.912	.898	.885	.871	.856	.840	.825
-15	.965	.959	.955	.952	.946	.942	.929	.915	.894	.888	.875	.863	.849	.832	.819
-20	.955	.948	.945	.941	.937	.930	.918	.905	.892	.879	.863	.850	.838	.820	.808
-25	.942	.937	.934	.930	.924	.920	.905	.892	.880	.867	.852	.835	.822	.805	.792
-30	.929	.923	.920	.916	.912	.905	.894	.878	.866	.855	.837	.819	.805	.788	.775
-35	.916	.912	.906	.904	.895	.891	.879	.862	.850	.839	.821	.800	.785	.770	.754
-40	.905	.898	.894	.888	.883	.877	.866	.846	.835	.825	.806	.784	.768	.751	.729

PRESSURE ALTITUDE - ft.

Figure 4-45 Corrections to power check pressure

Engine power checks should not be carried out in ambient conditions denoted by this area of the table

AMBIENT TEMPERATURE (deg.C.)	-1,000	-500	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000	AMBIENT TEMPERATURE (deg.C.)
+51	52																		+51
+49	55	48	46																+49
+47	58	51	49	44															+47
+45	61	53	51	46	41														+45
+43	64	56	54	49	44	39													+43
+41	67	59	57	52	46	42	37												+41
+39	70	62	60	55	49	45	40	35											+39
+37	73	65	63	58	52	47	43	38	33										+37
+35	76	69	66	61	55	50	45	40	36	32									+35
+33	80	72	69	64	58	53	48	43	39	35	31								+33
+31	83	75	72	67	61	56	51	46	41	38	34	30							+31
+29	86	79	75	70	65	59	55	49	44	40	36	33	29						+29
+27	90	82	79	73	68	62	58	52	47	43	39	36	32	29					+27
+25	93	85	82	77	71	66	61	55	51	46	42	39	34	31	28				+25
+23	97	89	85	80	74	69	64	59	54	49	45	42	37	34	30	27			+23
+21	100	92	89	83	78	72	68	62	57	53	48	45	40	37	33	30	26		+21
+19		96	93	87	81	76	71	65	61	56	52	48	43	40	36	32	29	25	+19
+17		99	96	91	85	79	75	69	64	60	55	51	46	43	39	35	31	28	+17
+15		100	100	94	89	83	78	72	68	63	59	54	50	46	42	38	34	31	+15
+13				98	92	87	82	76	71	67	62	58	53	49	45	41	37	34	+13
+11				100	96	90	86	80	75	70	66	62	57	53	48	44	40	37	+11
+ 9					100	94	90	84	79	74	70	65	60	56	52	48	44	40	+ 9
+ 7						98	94	88	83	78	73	69	64	60	56	51	47	43	+ 7
+ 5						100	98	92	87	82	77	73	68	64	59	55	50	46	+ 5
+ 3							100	96	91	86	82	77	72	68	63	59	54	50	+ 3
+ 1								100	95	90	86	81	76	72	67	62	58	54	+ 1
- 1									99	94	90	85	80	76	71	66	62	58	- 1
- 3									100	99	94	89	84	80	75	70	66	62	- 3
- 5										100	99	93	89	84	79	74	70	66	- 5
- 7											100	98	93	89	84	78	74	70	- 7
- 9												100	98	93	88	83	79	74	- 9
-11													100	98	93	87	83	79	-11
-13														100	97	92	88	83	-13
-15															100	97	93	88	-15
-17																100	97	93	-17
-19																	100	98	-19
-21																		100	-21

FULL INCREASE

PRESSURE ALTITUDE (ft.)

G1824

Fuel datum position (tabular)

Figure 4-47

In addition, on the pedestal are installed the lever panel covering the lever base and the side panels covering the both sides of the pedestal.

The front box is fixed to the floor beam with the four bolts located at the four corners of the bottom.

The lever base made of thick aluminum alloy casting bridges the front box and the rear box.

Its forward end is fixed to the front box with two bolts and its recessed portion just fits on the front box.

The rear box is fixed to the floor beam with the four bolts on the bottom.

The switch boxes (low stop, throttle and H.P.C. switch boxes from the left to the right) are attached to two angles in the front box.

(2) Details of Throttle Lever (Fig. 4-20)

The throttle lever can be rotated from the minimum position to the maximum position around the throttle shaft. On the both ends of the throttle lever are attached the discs and on its left side provided the throttle friction lever which is mounted on the throttle shaft.

To fix the throttle lever at a given position, the friction lock lever is used. Then the adjust nut pushes the spring plate which, in turn, pushes the disc, locking the throttle lever.

At the root of the throttle lever and the L.H. and R.H. discs are provided color marking which is necessary for rigging. Be careful especially not to erase the marking on the discs.

Reference point at 55° .... Blue mark

Reference point at 50° .... Red mark

Reference point for throttle
micro switch .... White mark

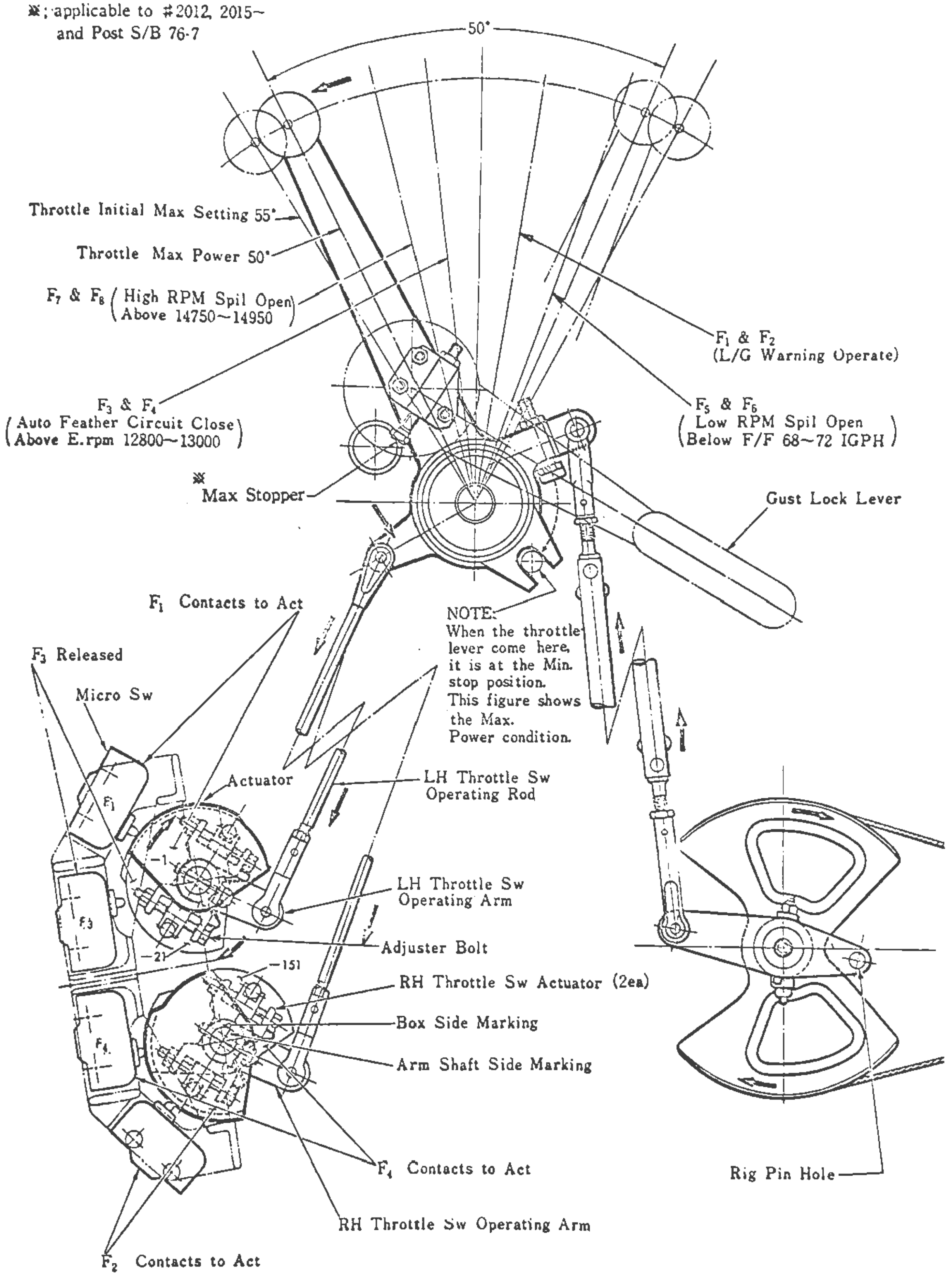
The primary stoppers for the throttle travel irrespective as to whether they are max. stops or min. stops, are located in the control box on the engine side.

If the throttle lever is moved, the forward arm at the root moves the throttle micro switch group actuating rod.

The rear arm moves the throttle rod for the engine power control.

(3) Details of Low Stop Lever (Fig. 4-21)

The left end of the low stop shaft is supported by a ball bearing fitted in a bracket. The bracket is mounted on the lever base with two bolts.


※; applicable to #2012, 2015~ and Post S/B 76-7
50°
Throttle Initial Max Setting 55°
Throttle Max Power 50°
F7 & F8 (High RPM Spil Open Above 14750~14950)
F3 & F4 (Auto Feather Circuit Close Above E.rpm 12800~13000)
※ Max Stopper
F1 & F2 (L/G Warning Operate)
F5 & F6 (Low RPM Spil Open Below F/F 68~72 IGPH)
Gust Lock Lever
NOTE: When the throttle lever come here, it is at the Min. stop position. This figure shows the Max. Power condition.
F1 Contacts to Act
F3 Released
Micro Sw
Actuator
F1
F3
F4
-1
-21
-151
LH Throttle Sw Operating Rod
LH Throttle Sw Operating Arm
Adjuster Bolt
RH Throttle Sw Actuator (2ea)
Box Side Marking
Arm Shaft Side Marking
F4 Contacts to Act
Rig Pin Hole
RH Throttle Sw Operating Arm
F2 Contacts to Act

Operating Point of Throttle Lever
Figure 4-27

(A) Check points

a. Behind the high stop withdrawal groove
b. In front of the fuel ON groove
c. Behind the fuel ON groove
d. In front of the fuel OFF groove
e. Behind the fuel OFF groove
f. In front of the feather groove.

(3) Adjustment of Throttle Trimmer

(A) Adjust the length of the arm, 01-64566-7 connecting the trim idler arm and the ball end to the standard dimension of 81.0 mm (reference) and adjust the length of the idler arm, 01-64592-41 on the fire wall to the standard dimension of 65.0 mm (reference).

(B) Set the trimmer switch of the pedestal in "INC" and make sure that the spring of the trim actuator rod end is not slack excessively.

(C) Set the gap between the trimmer pickup lever of the engine control box and the increase stopper to 0.012" to 0.014" and adjust the length of the rod connecting the fire wall idler arm ball end, engine pickup lever trimmer rod and lever from the trimmer actuator.

(D) Place the throttle pickup lever of the engine control box in contact with the min. stopper of the engine control box.

(E) Place the trimmer switch of the pedestal in DEC and extend the trimmer actuator fully. Then, make sure that the spring of the rod end of the trimmer actuator is not slack excessively.

(F) Make sure that the trimmer pickup lever of the engine control box is in contact with the decrease stopper positively.

A. Adjustment of Trimmer Actuator -- Trimmer Position Transmitter -- Trimmer Position Indicator

(a) Adjust the length of the lever arm of the trimmer position transmitter to the design value of 50 mm (Fig. 4-30).

(b) Place the pedestal trimmer switch in INC while the throttle pickup lever of the engine control box is in contact with the max. stopper and extract the trimmer actuator fully. Adjust the length of the adjustable link so that the pedestal trimmer position indicator registers 100%.

(c) Place the pedestal trimmer switch in DEC while the throttle pickup lever is in contact with the min. stopper and extend the trimmer actuator fully. Make sure that the pedestal trimmer position indicator registers 0%.

NOTE: When the trimmer position indicator does not indicate 0%, repeat 8(3) A(b) and (c) to meet the requirements, neglecting 8(3) A(a) (adjusting the length of the arm of the trimmer position transmitter lever to values other than the design value).

c. Continuous rating in excess of 800A.

4.9.2.3 Precautions prior to Starting

(1) If the throttle lever and the H.P. cock lever are opened simultaneously while the engine is shut down and the power is on, the propeller auto feathering circuit is made and auto feathering takes place. It is desirable to trip the auto feathering circuit breaker to avoid this.

(2) Be sure that the propeller blade is at the ground fine pitch. (Make sure that the red marks on the spinner and the blade are lined up.)

(3) Make sure that sufficient amounts of fuel and W/M for ground running are loaded on the aircraft.

WARNING: 1. Avoid continuous operation at a speed less than 7,000 rpm.

2. Minimize engine operation at a speed between 12,000 and 14,000 rpm.

4.9.2.4 Precautions during Starting

✓(1) T.G.T. at engine starting shall not exceed 930°C. If the T.G.T. is about to exceed 930°C, place the H.P. cock lever in Fuel OFF and shut down the engine immediately.

✓(2) Never push the starter motor button while the propeller is still rotating.

(3) Do not pull out the starter button before the engine speed reaches 3500 rpm, or the engine is perfectly ignited except when the T.G.T. is excessively high.

(4) If the engine is not ignited within 20 sec. or the engine speed does not increase from the motoring speed, place the starter master switch in SAFE within 30 sec.

(5) Do not run the starter motor in excess of 30 sec.

4.9.2.5 Warning after Starting

(1) Make sure that the instruments in the cockpit are normal.

(2) Minimize the ground running time.

(3) Avoid the extended engine operation under maximum conditions.

(4) Avoid abrupt operation of the throttle lever and move it smoothly and slowly.

NOTE: If the throttle lever is moved abruptly, the torque pressure response will be delayed, resulting in auto feathering.

If the T.G.T. reaches this limit, place the H.P. cock lever in Fuel Off immediately.

(2) If the T.G.T. exceeds the normal operating maximum T.G.T. during the engine running, record it in the engine log book.

4.9.4 Engine Data

The engine data are given in the "inspection and test certificate" of the engine log book for the particular serial number.
The engine data plate is also used.
The data are based on the international standard atmosphere, sea level (I.S.A., S.L. conditions).

4.9.5 Data Plate Correction

Before commencing the ground run, it is necessary to correct the individual engine data according to the atmospheric conditions.

4.9.5.1 How to obtain atmospheric conditions

(1) Outside air temperature (O.A.T.)

It taken from the aircraft involved or a thermometer located in a nearby well ventilated run shade, free from the radiation effects.

(Reference)

It is desirable to use a thermometer located around the ADF sense antenna on the lower surface of the fuselage or around the lower part of the nose landing gear bay.

NOTE: O.A.T. value below the desimal point should be rounded to an integer by counting fractions of .5 and over as a whole number and disregarding the rest.

(2) Pressure Altitude

a. It is taken from the information given by the tower of the airport in which the ground run is conducted.

b. It is taken from the calibrated altimeter installed in the aircraft in terms of pressure in mercury column after setting it to the field elevation of the aircraft.

NOTE: 1. Either one of the above methods a. and b. may be used.

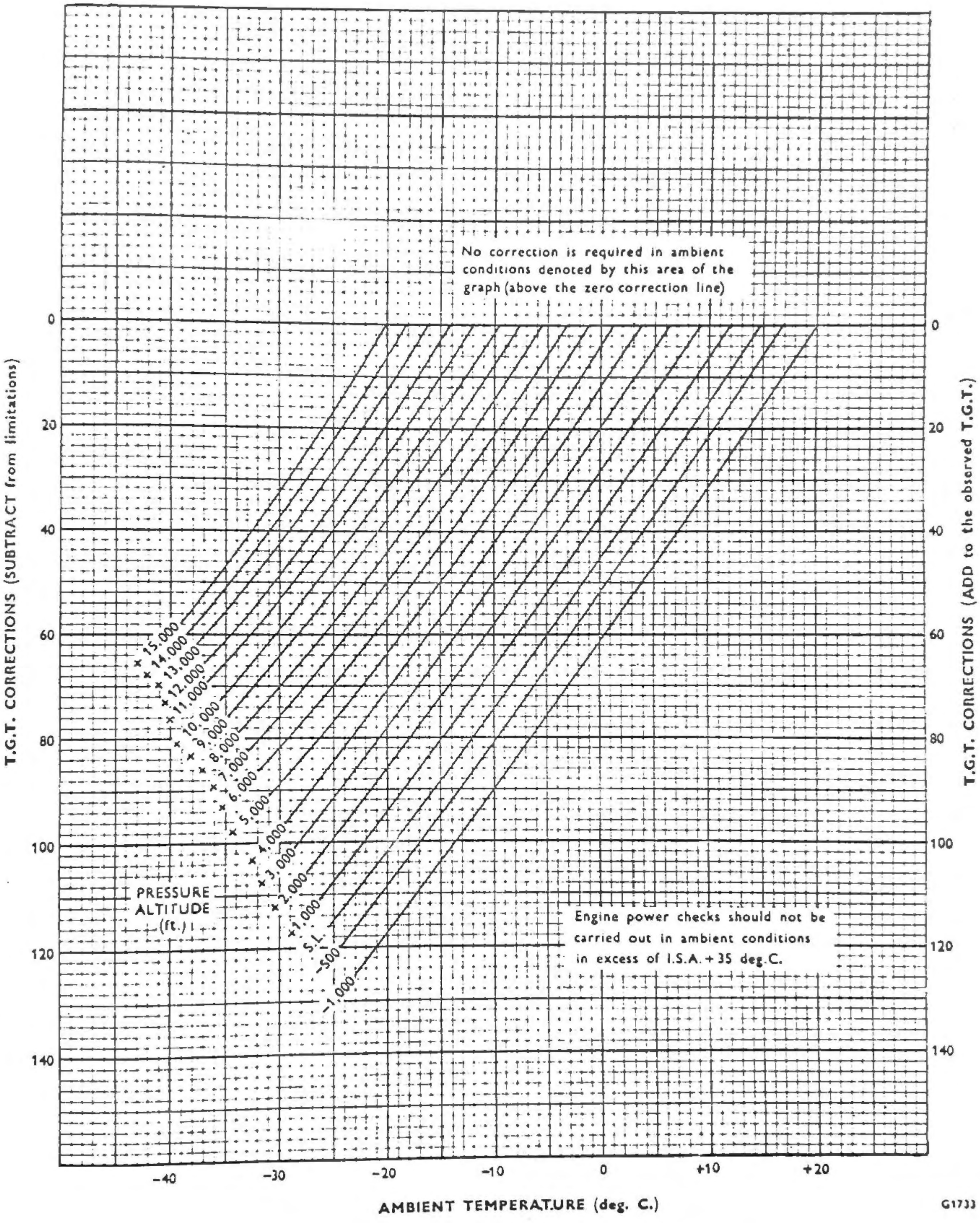
2. For the conversion between the pressure in mercury column and the pressure altitude, see Fig. 4-42.

INCHES※	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
29.0	863	853	844	834	825	815	806	796	787	777
29.1	768	758	749	739	730	721	711	702	692	683
29.2	673	664	655	645	636	626	617	607	598	589
29.3	579	570	560	551	542	532	523	514	504	495
29.4	485	476	467	457	448	439	429	420	410	401
29.5	392	382	373	364	354	345	336	326	318	308
29.6	298	289	280	270	261	252	242	233	224	215
29.7	205	196	187	177	168	159	149	140	131	122
29.8	112	103	94	85	75	66	57	47	38	29
29.9	20	10	+1	-8	-17	-26	-36	-45	-54	-63
30.0	-73	-82	-91	-100	-110	-119	-128	-137	-146	-156
30.1	-165	-174	-183	-192	-202	-211	-220	-229	-238	-248
30.2	-257	-266	-275	-284	-293	-303	-312	-321	-330	-339
30.3	-348	-358	-367	-376	-385	-394	-403	-412	-421	-431
30.4	-440	-449	-458	-467	-476	-485	-495	-504	-513	-522
30.5	-531	-540	-549	-558	-567	-576	-585	-594	-604	-613

※ OF MERCURY

(ALTITUDE PRESSURE TABLE)
(CONVERSION TABLE)

Figure 4-42



T.G.T. corrections at 15,000 r.p.m. (graphical)
Figure 4-43

Engine power checks should not be carried out in ambient conditions in excess of I.S.A. +35 deg. C.

NO CORRECTION

AMBIENT TEMPERATURE (deg.C.)	-1,000	-500	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000	AMBIENT TEMPERATURE (deg.C.)
+21	0																		+21
+19	3																		+19
+17	9	0																	+17
+15	16	6	0																+15
+13	22	12	5	0															+13
+11	28	18	12	3															+11
+ 9	34	24	18	10	0														+ 9
+ 7	40	30	24	16	7	0													+ 7
+ 5	46	36	30	22	13	4	0												+ 5
+ 3	52	43	36	28	20	10	2												+ 3
+ 1	58	49	42	34	26	17	8	0											+ 1
- 1	64	55	48	40	32	23	14	7	0										- 1
- 3	70	60	54	46	38	29	21	13	6	0									- 3
- 5	76	66	60	52	44	35	27	20	12	5	0								- 5
- 7	81	72	66	58	49	41	33	26	19	11	5	0							- 7
- 9	87	78	72	64	55	47	39	32	25	18	11	4	0						- 9
-11	92	83	79	69	61	53	45	38	31	24	17	10	4	0					-11
-13	98	89	83	74	66	58	51	44	37	30	23	16	10	3	0				-13
-15	104	94	88	80	72	64	56	50	43	36	29	23	16	9	3	0			-15
-17	109	100	94	86	78	70	62	55	48	41	35	29	23	16	10	3	0		-17
-19	114	105	99	91	83	75	68	61	54	47	41	34	29	22	16	9	3	0	-19
-21	120	111	104	96	88	81	73	66	59	52	46	40	34	28	22	16	9	3	-21
-23	126	116	110	102	94	86	79	72	64	58	52	46	40	34	28	22	16	10	-23
-25			115	107	99	92	84	77	70	63	57	51	46	40	34	28	22	16	-25
-27					104	97	90	82	75	68	62	56	51	45	40	34	28	23	-27
-29							95	87	80	73	68	62	56	50	46	40	34	29	-29
-31								91	84	78	72	66	61	56	51	46	40	35	-31
-33										83	77	72	66	61	56	51	46	41	-33
-35												76	71	66	61	56	51	47	-35
-37															66	61	56	52	-37
-39																		57	-39

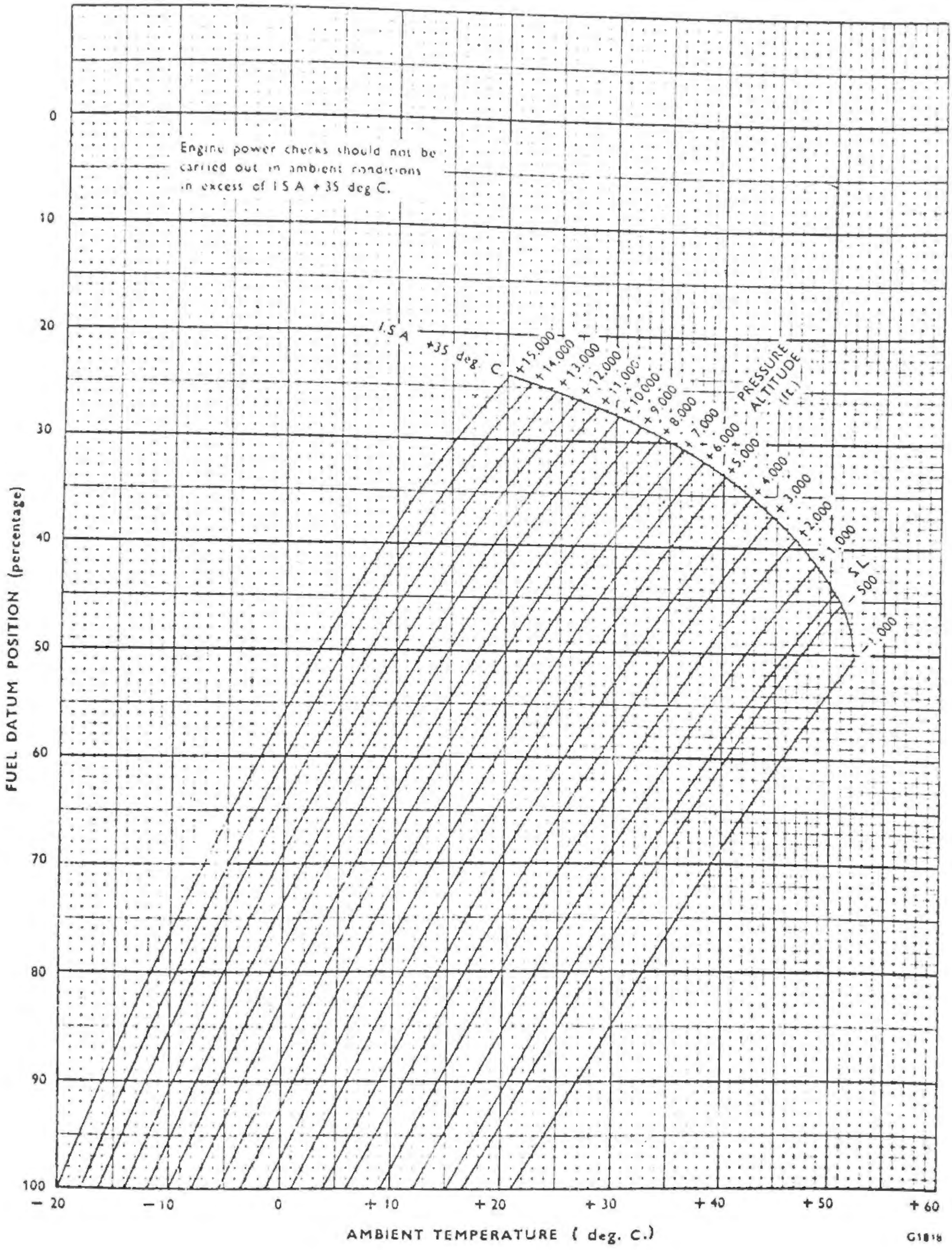
PRESSURE ALTITUDE (ft.)

G1746

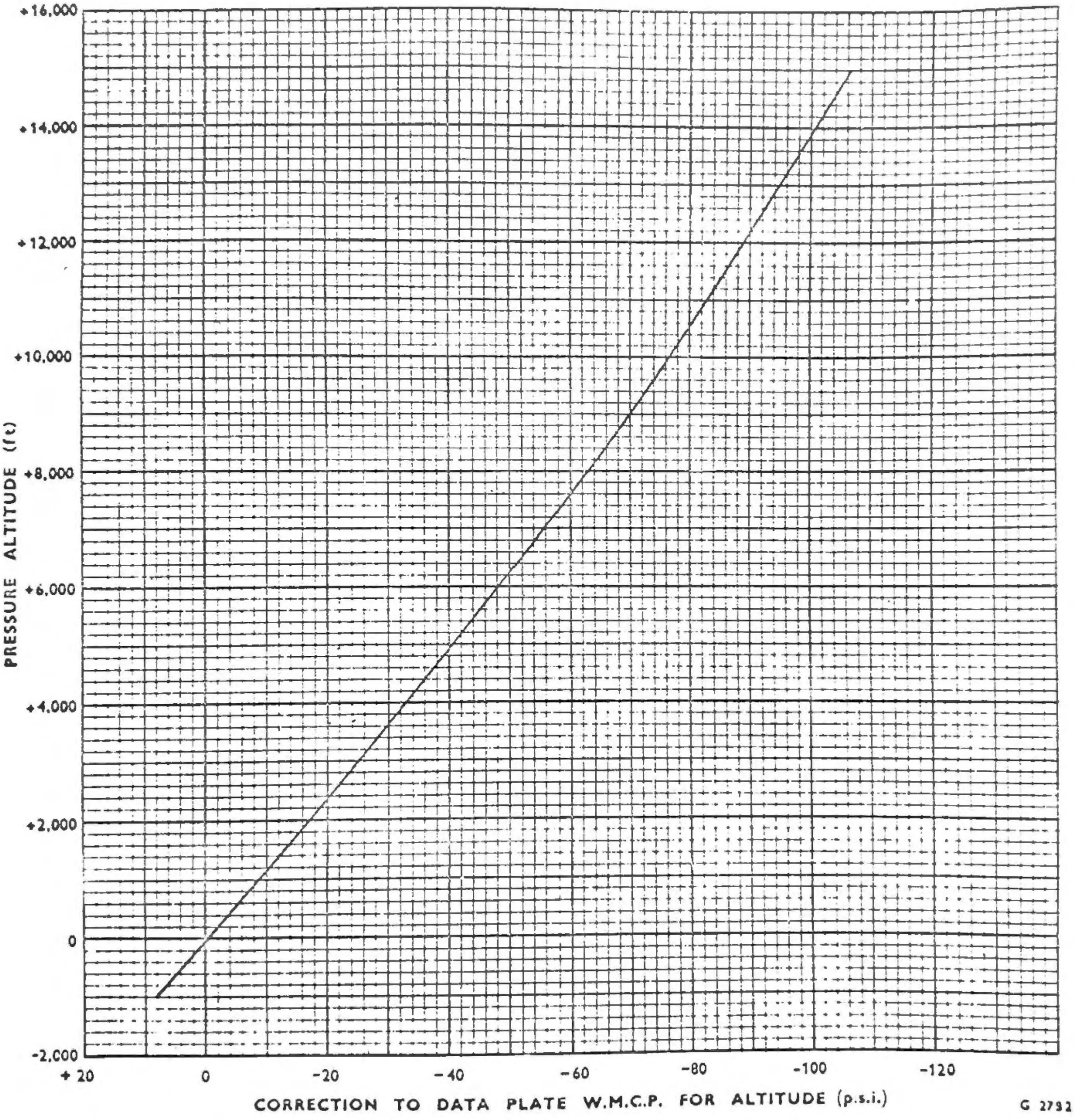
NOTE: Subtract the correction value obtained from this table from the appropriate T.G.T. limitation

T.G.T. corrections at 15,000 r.p.m. (tabular)

Figure 4-44



Fuel datum position (graphical)
Figure 4-46



Corrections to W.M.C.P. for altitude
Figure 4-48

4.9.5.6 Correction for Humidity

The fuel datum setting and power check pressures may be corrected for humidity if necessary.

NOTE: Unless it is known that conditions of very high humidity prevail, the humidity corrections need not be used for routine ground runs, and reference to these corrections should be ignored. The humidity corrections should be used on engines with low torque pressure which may, given the benefit of the correction, avoid being rejected.

(Example)

Engine data:

Ambient (dry bulb - T_O) temperature	+13°C
Wet bulb (T_W) temperature	+12°C
Pressure altitude	29.83hg.in≒100ft
MAX T.G.T	845°C
MIN T.G.T	815°C
E.P.C.P	345 psi
W.M.C.P	410 psi

(1) T.G.T Correction

Based on O.A.T and the pressure altitude at the location and the time, amount of compensation, using Fig. 4-43 and 4-44

(Example)

Max. T.G.T Correction = 845°C - 4.5°C = 840.5°C ≒ 841°C
Min. T.G.T Correction = 815°C - 4.5°C = 810.5°C ≒ 811°C

(2) W.M.C.P Correction

Based on the pressure altitude at the location, amount of compensation, using Fig. 4-48.

(Example)

W.M.C.P Correction = 410 psi + (-0.7 psi)
= 409.3 psi ≒ 409 psi

(3) E.P.C.P Correction

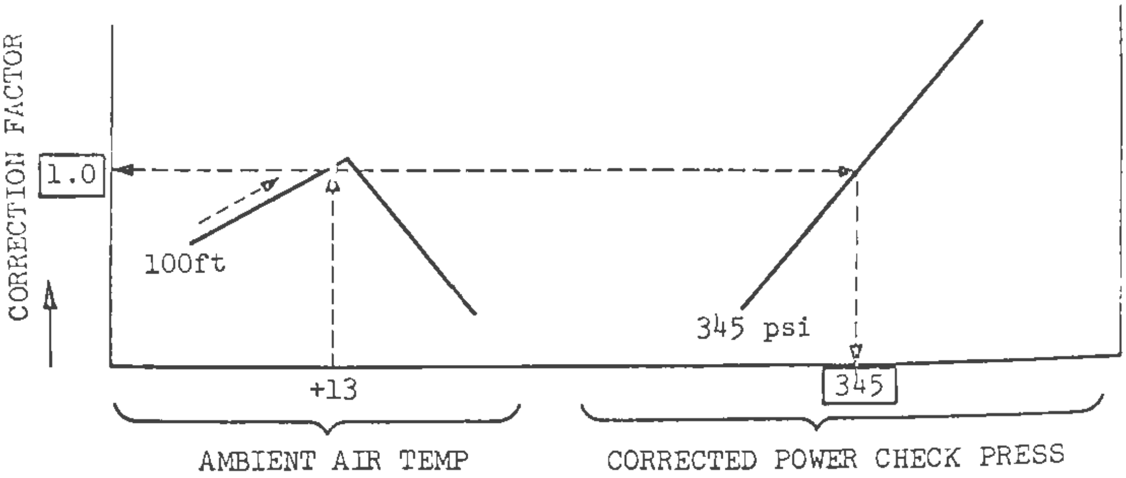
There are two methods of solution for correction so that graphical solution, and tabular solution. In practice it will usually be necessary to interpolate between the figures given in the tables.

A. Graphical Solution

(A) Correct the power check pressure for the prevailing ambient temperature and pressure altitude, using Fig. 4-49, Fig 4-50.

Fig. 4-49 .... Full range
Fig. 4-50 .... Reduced range

(Example)

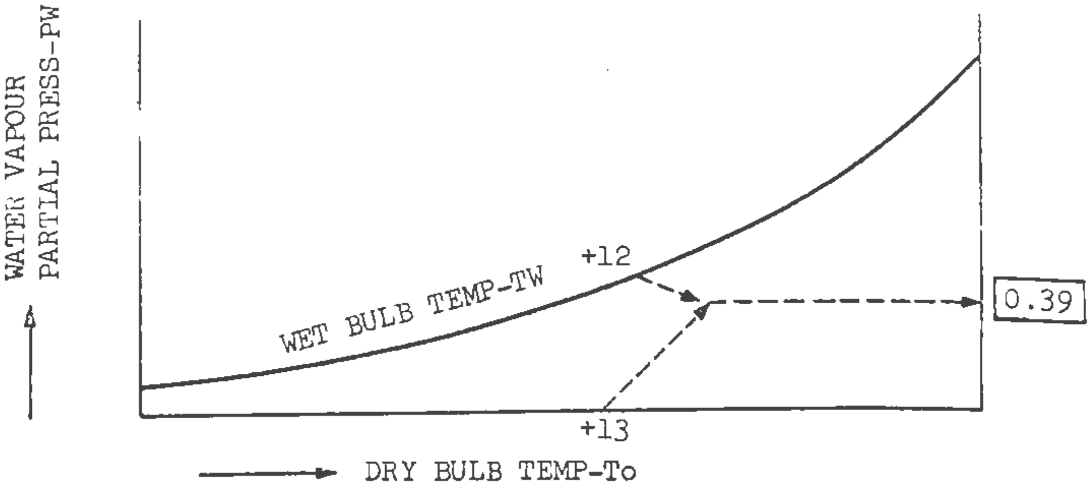


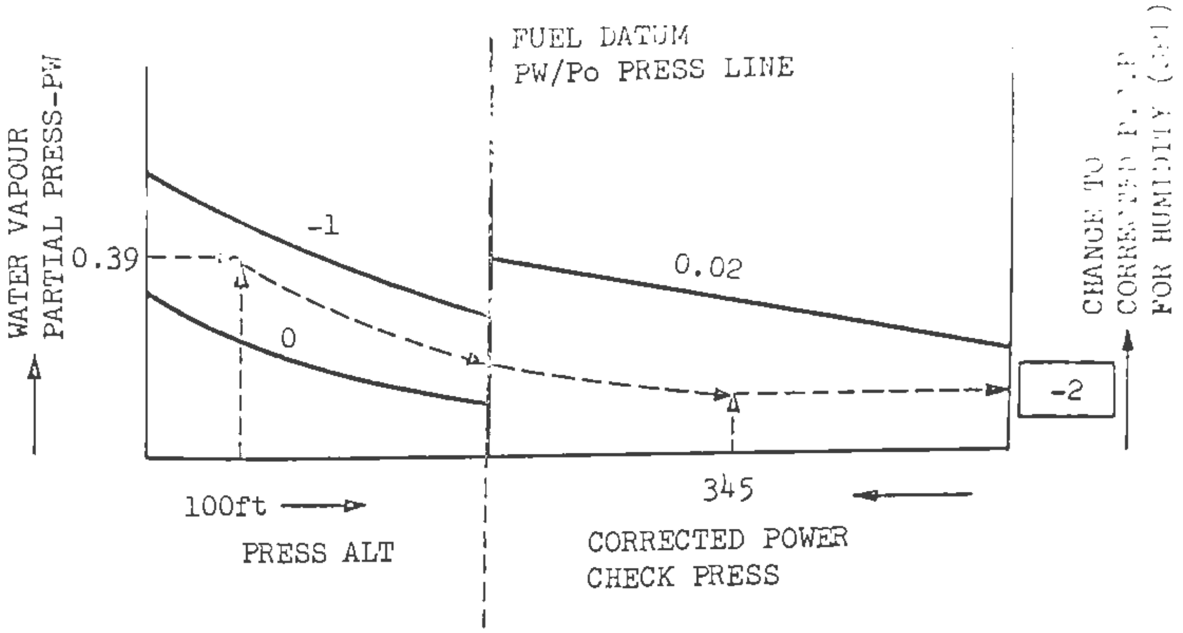
The amount of corrected power check pressure obtained from Fig. 4-49 is as following.

Corrected P.C.P = 345 psi

(B) Change the corrected P.C.P for humidity, using Fig. 4-53, Fig 4-54.

(Example)





The corrected E.P.C.P for humidity
= (Corrected P.C.P of engine data plate) + (P.C.P compensation for humidity)

= 345 psi + (-2 psi) = 243 psi

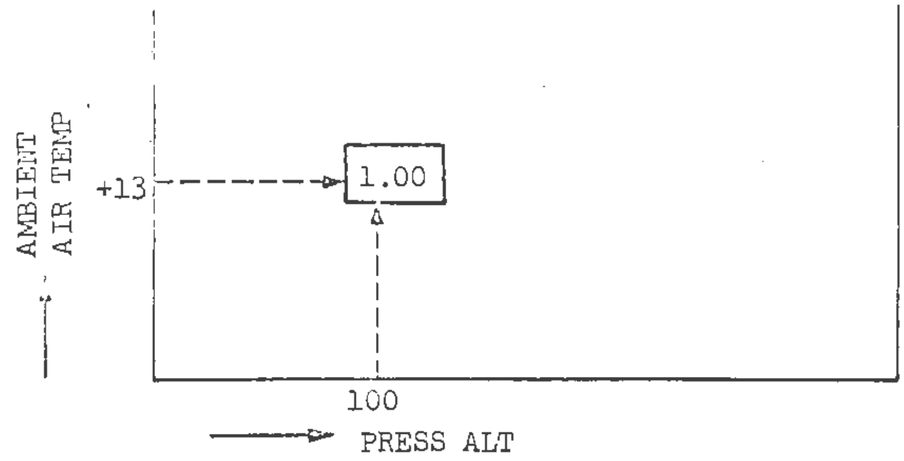
This is the corrected E.P.C.P value for humidity.

B. Tabular solution

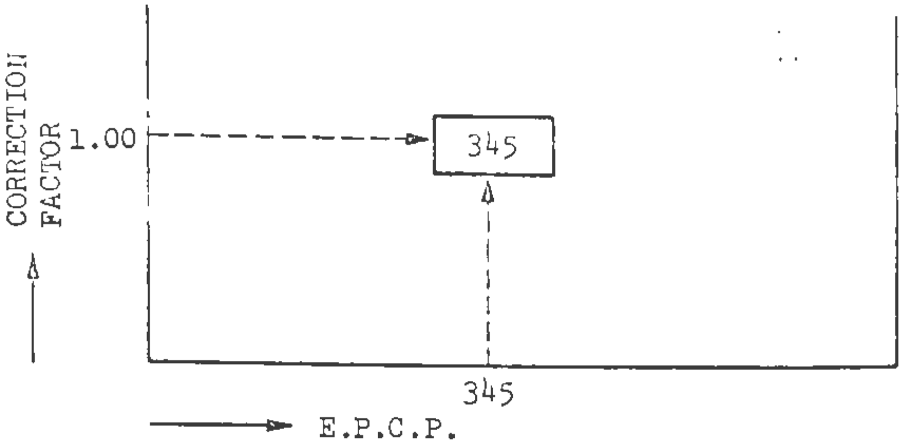
NOTE: In practice it will usually be necessary to interpolate between the figures given in the tables.

(A) Correct the power check pressure for the prevailing ambient temperature and pressure altitude, using Fig. 4-51, Fig. 4-52.

(Example)



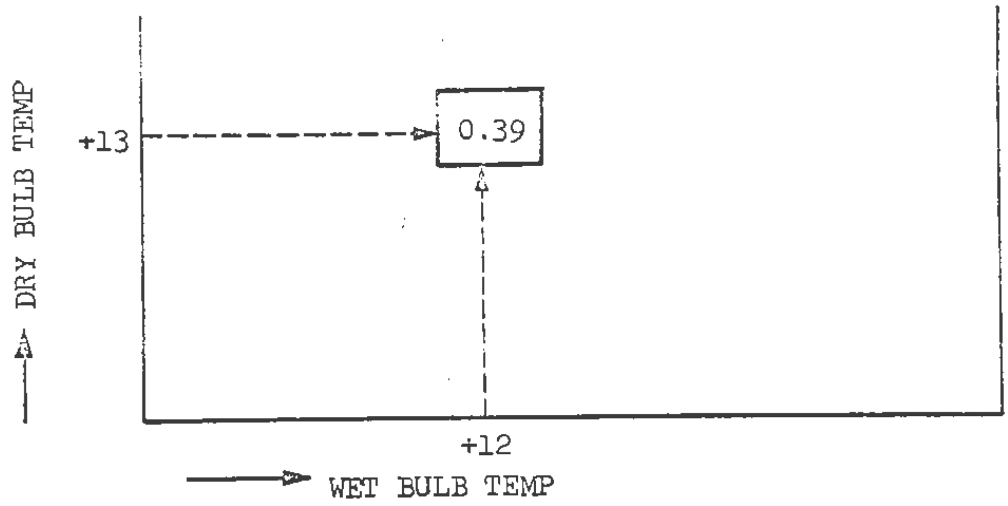
CORRECTION FACTOR = 1.00

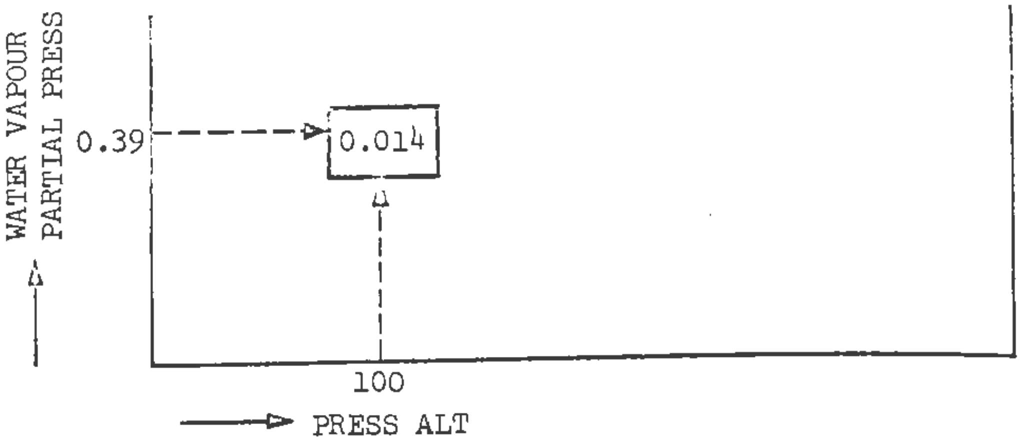


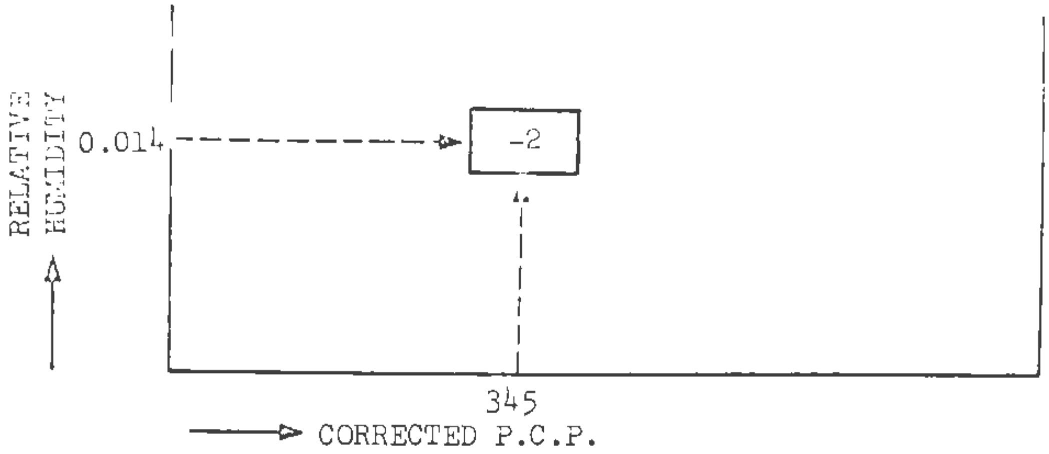
CORRECTED P.C.P=345PSI

(B) Change the corrected P.C.P for humidity, using Fig. 4-55, Fig. 4-57, Fig. 4-58.

(Example)







The corrected E.P.C.P for humidity
= (Corrected P.C.P of engine data plate) + (P.C.P compensation for humidity)

= 345 psi + (-2 psi) = 243 psi

This is the corrected E.P.C.P value for humidity.

(4) Fuel Datum Setting

A. Graphical Solution

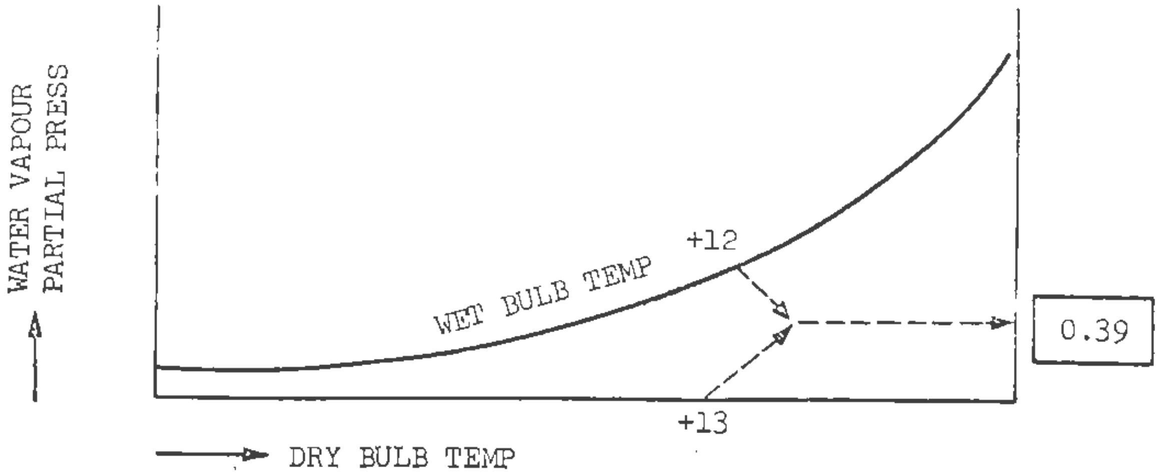
(A) Set the fuel datum for the prevailing ambient temperature, using Fig. 4-46, Fig. 4-47.

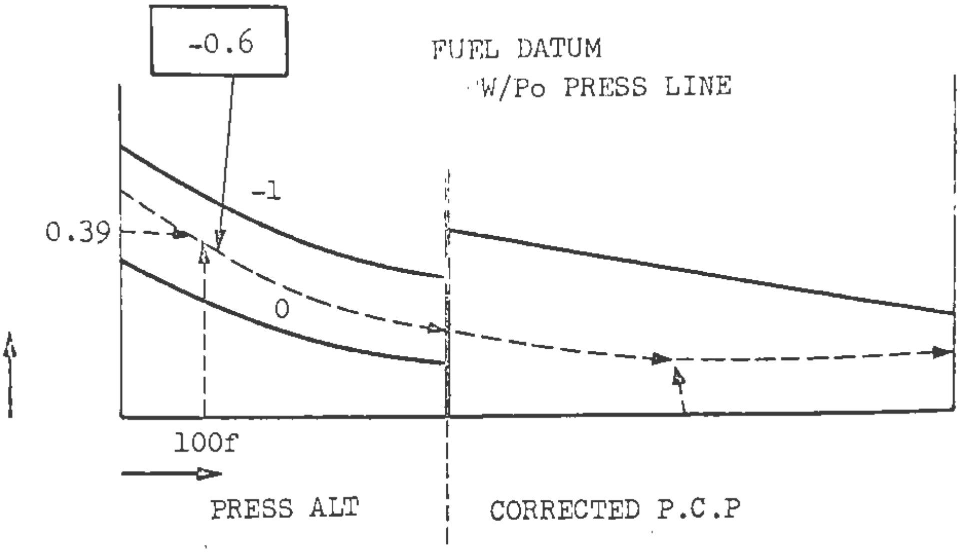
(Example) O.A.T +13°C

Fuel datum setting 100%

(B) Correct the fuel datum setting for the humidity, using Fig. 4-53, Fig. 4-54.

(Example)





The corrected fuel datum setting for humidity
= (Corrected fuel datum setting of prevailing ambient temp.)
+ (Setting compensation for humidity)
= 100 + (-0.6) ≒ 99%

This is the corrected fuel datum value for humidity.

B. Tabular Solution

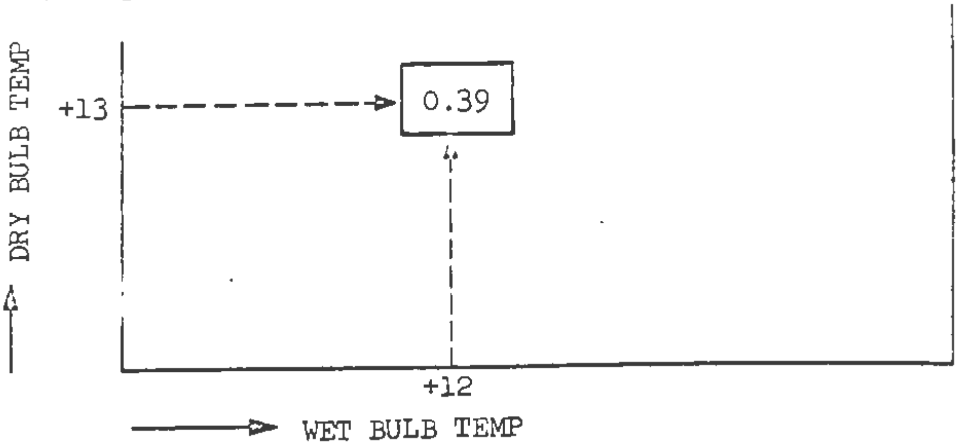
(A) Set the fuel datum for the prevailing ambient temperature using Fig. 4-46, Fig. 4-47.

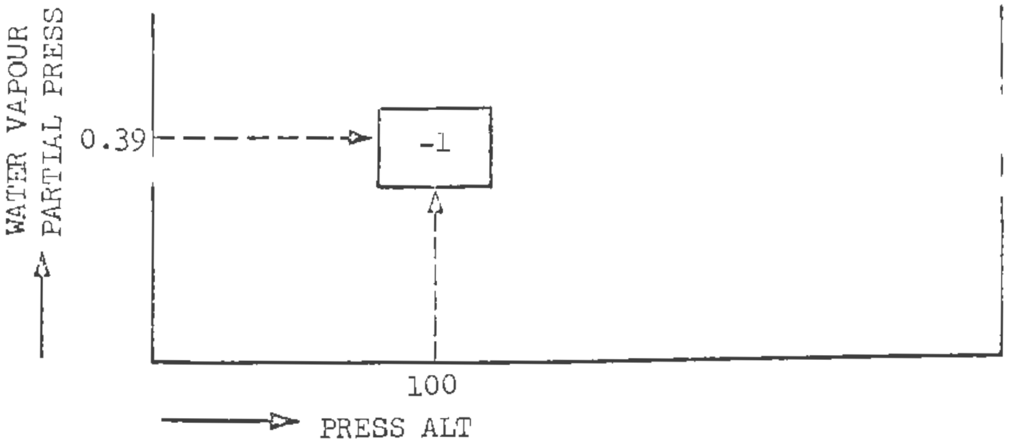
(Example)

O.A.T .... +13°C
Fuel datum setting 100%

(B) Correct the fuel datum setting for the humidity, using Fig. 4-55, Fig. 4-56.

(Example)





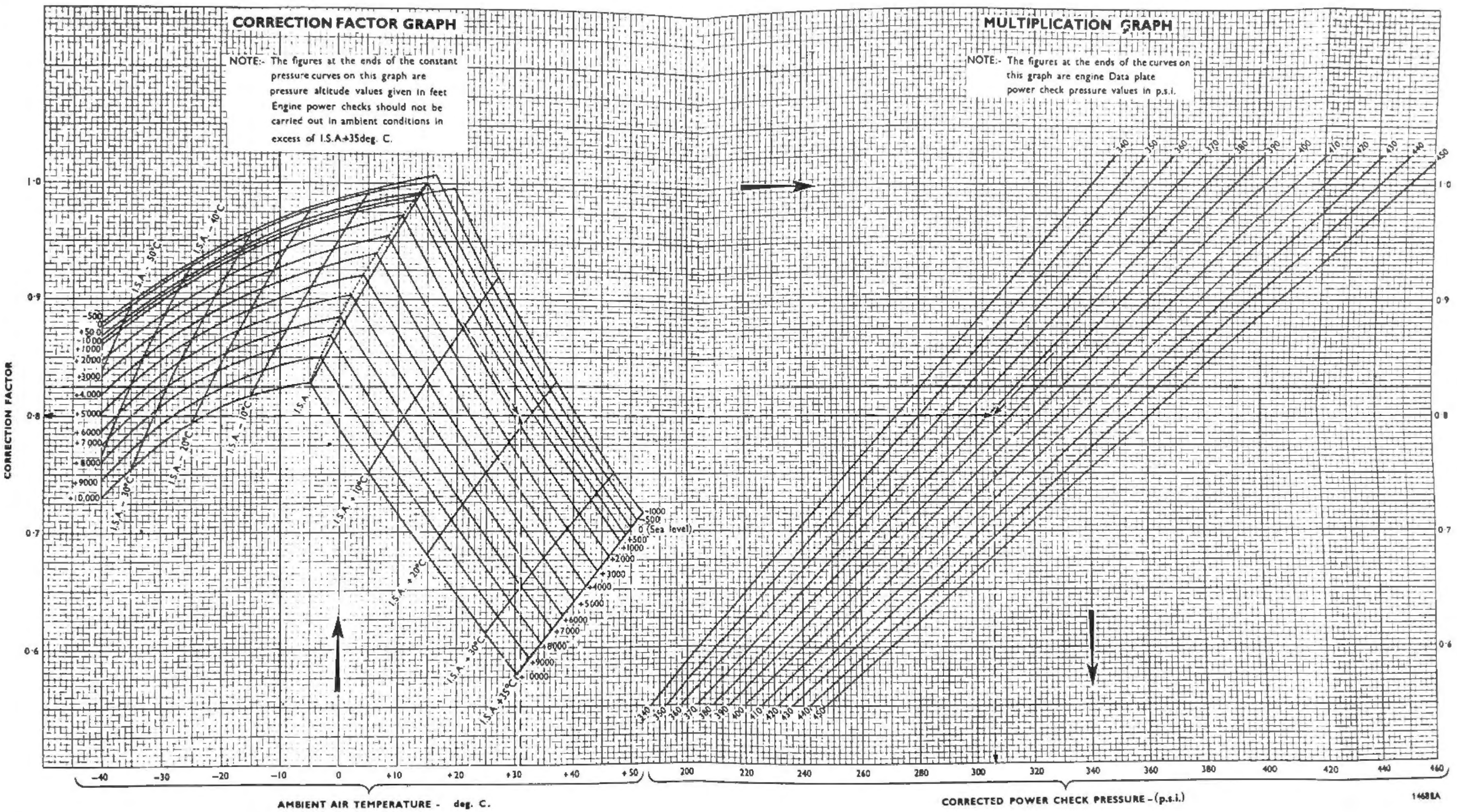
The corrected fuel datum setting for humidity.

= (Corrected fuel datum setting of prevailing ambient temp.)
  + (Setting compensation for humidity)

= 100 + (-1) = 99%

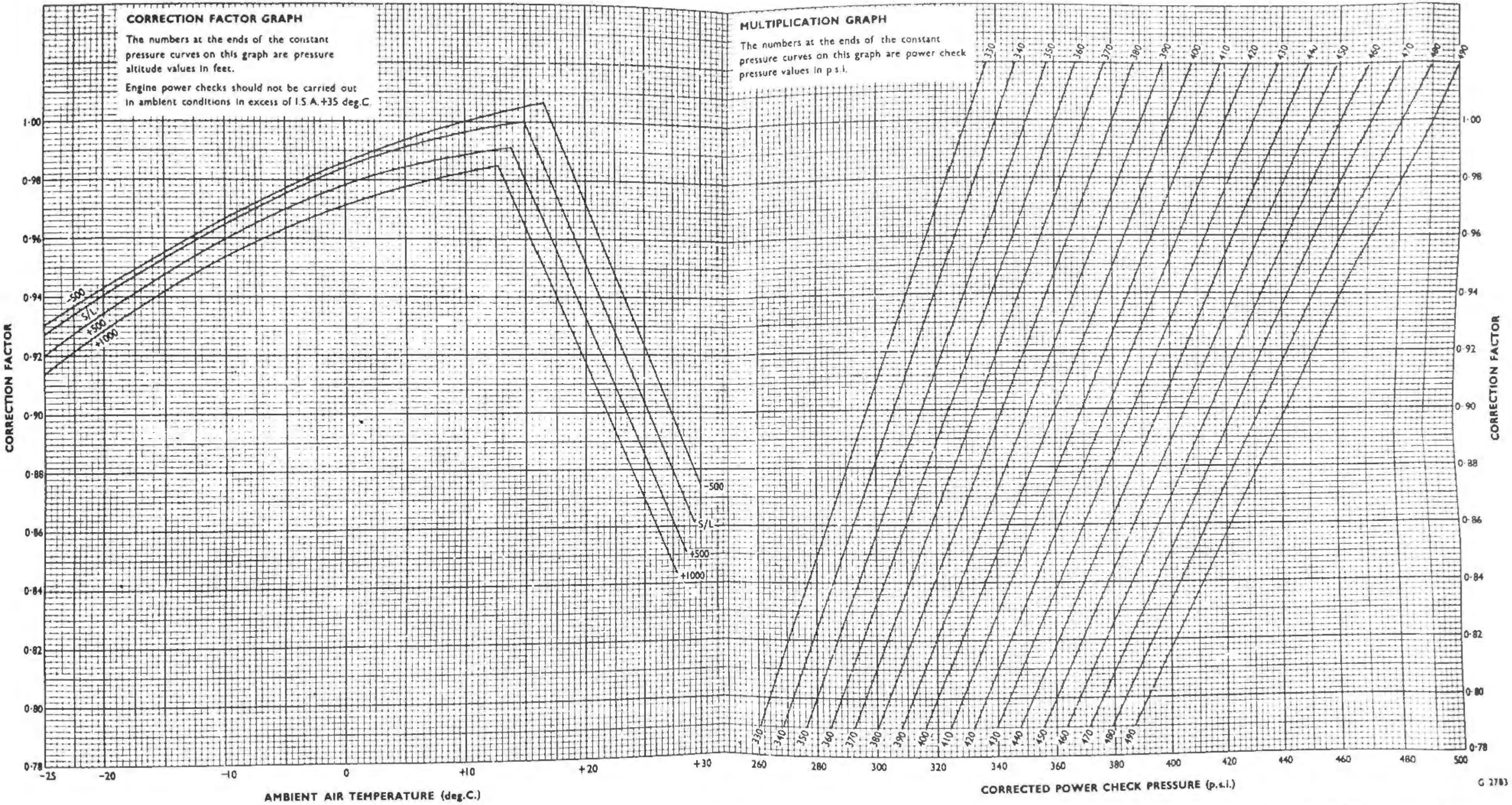
This is the correction fuel datum value for humidity.

Reserved



Corrections to Power Check Pressure
(full range) - graphical
Figure 4-49

NOTE: A tabular representation of this graph is shown in Fig.507a and 507b, and a reduced range graph with extended scale is shown in Fig. 4-50



NOTE: A tabular representation of this graph is shown in Fig. 4-51 and 4-52 and a full range graph with a reduced scale is given in Fig. 4-49.

Corrections to Power Check Pressure
(reduced range) - graphical
Figure 4-50

CORRECTION TABLE

AMBIENT AIR TEMPERATURE (deg.C.)	-1,000	-500	0	+500	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	AMBIENT AIR TEMPERATURE (deg C.)
+50	0.73	0.72	0.70	0.69	0.68	0.65									+50
+45	0.77	0.75	0.74	0.73	0.71	0.69	0.66	0.63							+45
+40	0.81	0.79	0.78	0.76	0.75	0.72	0.69	0.67	0.64	0.62					+40
+35	0.85	0.83	0.82	0.80	0.79	0.76	[illegible]	[illegible]	0.68	0.65	0.63	0.60			+35
+30	0.89	0.87	0.86	0.84	0.83	0.80	0.77	0.74	0.71	[illegible]	0.66	0.63	0.61	0.58	+30
+25	0.94	0.92	0.90	0.89	0.87	0.84	0.81	0.78	0.75	0.72	0.69	0.67	0.64	0.61	+25
+20	0.99	0.97	0.95	0.93	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.70	0.68	0.65	+20
+15	0.99	1.01	1.00	0.98	0.96	0.93	0.89	0.86	0.83	0.80	0.77	0.74	0.71	0.68	+15
+10	0.99	1.00	1.00	0.99	0.98	0.97	0.94	0.91	0.87	0.84	0.81	0.78	0.75	0.72	+10
+ 5	0.98	0.99	0.99	0.98	0.98	0.97	0.95	0.94	0.91	0.88	0.85	0.82	0.79	0.75	+ 5
0	0.97	0.99	0.98	[illegible]	0.97	0.96	0.94	0.93	0.92	0.90	0.88	0.86	0.82	0.79	0
- 5	0.97	0.98	0.98	0.97	0.96	0.95	[illegible]	[illegible]	0.91	0.90	0.88	0.87	0.85	0.83	- 5
-10	0.96	0.97	0.97	0.96	0.95	0.94	[illegible]	0.92	0.90	0.89	0.87	0.86	0.84	0.82	-10
-15	0.94	0.96	0.95	0.95	0.94	0.93	0.92	0.91	0.89	0.88	0.86	0.85	0.83	0.82	-15
-20	0.93	0.94	0.94	0.94	0.93	0.92	[illegible]	0.89	0.88	0.87	0.85	0.84	0.82	0.81	-20
-25	0.92	0.93	0.93	0.92	0.91	0.90	0.89	0.88	0.86	0.85	0.84	0.82	0.81	0.79	-25
-30	0.90	0.91	0.91	0.90	0.90	0.89	0.87	0.86	0.85	0.83	0.82	0.81	0.79	0.78	-30
-35	0.88	0.90	0.89	0.89	0.89	0.87	0.85	0.84	0.83	0.81	0.80	0.79	0.77	0.76	-35
-40	0.88	0.88	0.88	0.87	0.86	0.85	0.83	0.82	0.80	0.79	0.78	0.76	0.75	0.73	-40

Engine power check should not be carried out in ambient conditions in excess of I.S.A. + 35 deg C

PRESSURE ALTITUDE (ft.)

G2800

Corrections to Power Check Pressure - tabular
Figure 4-51

NOTE: A graphical representation of this table is shown in Fig.4-49(full range) and Fig.4-50(reduced range).

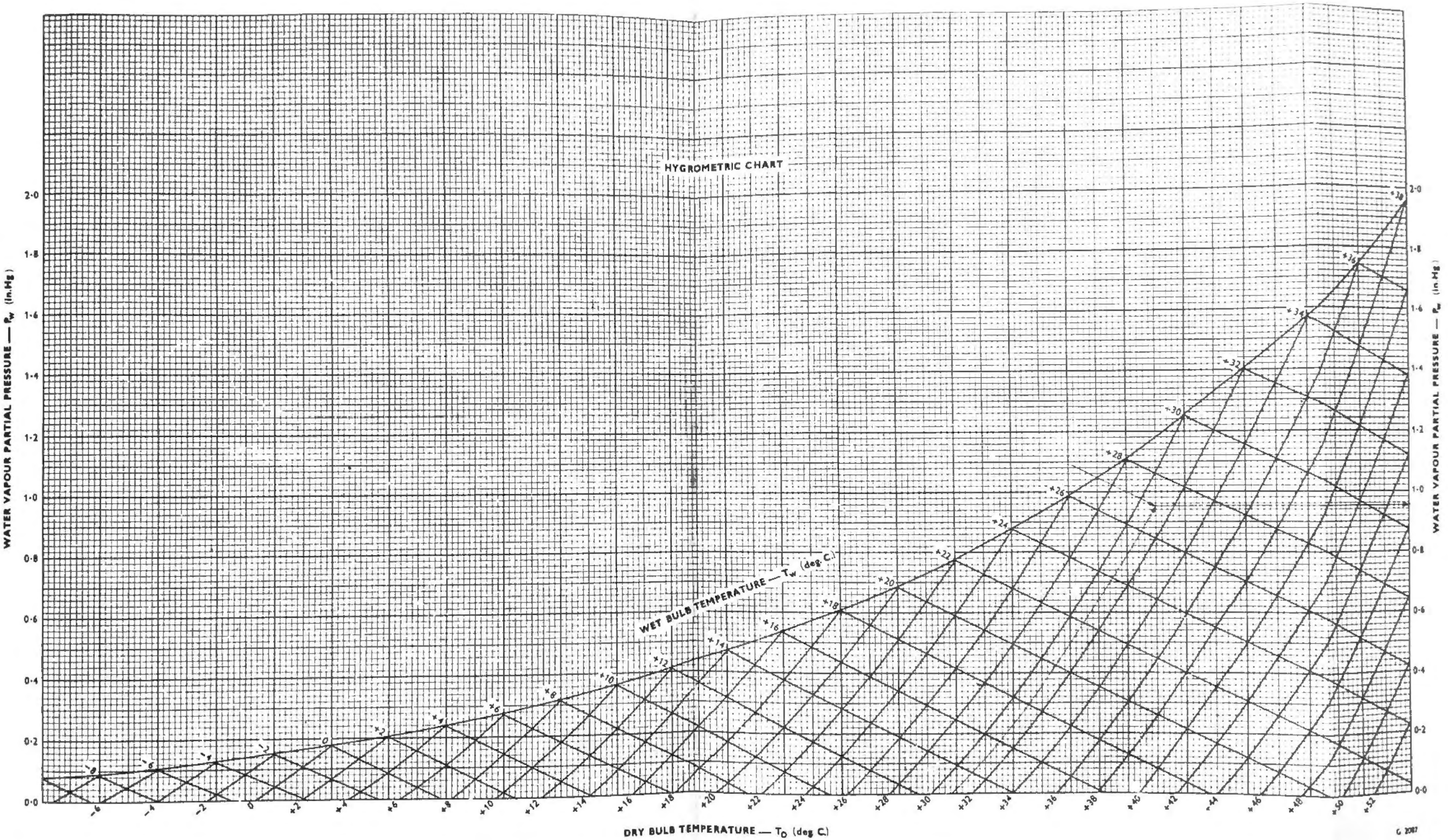
Reserved

1.03	309	314	319	324	330	335	340	345	350	355	361	366	371	376	381	386	391	397	402	407	412	417	422	427	433	438	443	448	453	458	464	469	474	479	484	489	494	500	505	510	515	520	525	530	536	541	546	551	556	561	567	572	577	580	587	592	597	603	608	613	619	1.03
1.02	306	311	316	321	326	332	337	342	347	352	357	362	367	372	377	383	388	393	398	403	408	413	418	423	428	434	439	444	449	454	459	464	469	474	479	485	490	495	500	505	510	515	520	525	530	536	541	546	551	556	561	566	571	576	581	587	592	597	602	607	612	1.02
1.01	303	308	313	318	323	328	333	338	343	348	354	359	364	369	374	379	384	389	394	399	404	409	414	419	424	429	434	439	444	449	455	460	465	470	475	480	485	490	495	500	505	510	515	520	525	530	535	540	545	550	556	561	566	571	576	581	586	591	596	601	605	1.01
1.00	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	485	490	495	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	576	580	585	590	595	600	1.00
0.99	297	302	307	312	317	322	327	332	337	342	347	351	356	361	366	371	376	381	386	391	396	401	406	411	416	421	426	431	436	441	446	450	455	460	465	470	475	480	485	490	495	500	505	510	515	520	525	530	535	540	545	549	554	559	564	569	574	579	584	589	594	0.99
0.98	294	299	304	309	314	319	323	328	333	338	343	348	353	358	363	368	372	377	382	387	392	397	402	407	412	417	421	426	431	436	441	446	451	456	461	466	470	475	480	485	490	495	500	505	510	515	519	524	529	534	539	544	549	554	559	564	568	573	578	583	588	0.98
0.97	291	296	301	306	310	315	320	325	330	335	341	344	349	354	359	364	369	373	378	383	388	393	398	403	407	412	417	422	427	432	437	441	446	451	456	461	466	470	475	480	485	490	495	500	504	509	514	519	524	529	534	538	543	548	553	558	563	567	572	577	582	0.97
0.96	288	293	298	302	307	312	317	322	326	331	336	341	346	350	355	360	365	370	374	379	384	389	394	398	403	408	413	418	422	427	432	437	442	446	451	456	461	466	470	475	480	485	490	494	499	504	509	514	518	523	528	533	538	542	547	552	557	562	566	571	576	0.96
0.95	285	290	295	299	304	309	314	318	323	328	333	337	342	347	352	356	361	366	371	375	380	385	390	394	399	404	409	413	418	423	428	432	437	442	447	451	456	461	466	470	475	480	485	489	494	499	504	508	513	518	523	527	532	537	542	546	551	556	561	565	570	0.95
0.94	282	287	291	296	301	306	310	315	320	324	329	334	338	343	348	353	357	362	367	371	376	381	385	390	395	400	404	409	414	418	423	428	432	437	442	447	451	456	461	465	470	475	479	484	489	494	498	503	508	512	517	522	526	531	536	541	545	550	555	559	564	0.94
0.93	279	284	288	293	298	302	307	312	316	321	326	330	335	339	344	349	353	358	363	367	372	377	381	386	391	395	400	405	409	414	419	423	428	432	437	442	446	451	456	460	465	470	474	479	484	488	493	498	502	507	512	516	521	525	530	535	539	544	549	553	558	0.93
0.92	276	281	285	290	294	299	304	308	313	317	322	327	331	336	340	345	350	354	359	363	368	373	377	382	386	391	396	400	405	409	414	419	423	428	432	437	442	446	451	455	460	465	469	474	478	483	488	492	497	501	506	511	515	520	524	529	534	538	543	547	552	0.92
0.91	273	278	282	287	291	296	300	305	309	314	319	323	328	332	337	341	346	350	355	359	364	369	373	378	382	387	391	396	400	405	410	414	419	423	428	432	437	441	446	450	455	460	464	469	473	478	482	487	491	496	501	505	510	514	519	523	528	532	537	541	546	0.91
0.90	270	275	279	284	288	293	297	302	306	312	315	320	324	329	333	338	342	347	351	356	360	365	369	374	378	383	387	392	396	401	405	410	414	419	423	428	432	437	441	446	450	455	459	464	468	473	477	482	486	491	495	500	504	509	513	518	522	527	531	536	540	0.90
0.89	267	271	276	280	285	289	294	298	303	307	312	316	320	325	329	334	338	343	347	352	356	360	365	369	374	378	383	387	392	396	401	405	409	414	418	423	427	432	436	441	445	449	454	458	463	467	472	476	481	485	490	494	498	503	507	512	516	521	525	530	534	0.89
0.88	264	268	273	277	282	286	290	295	299	304	308	312	317	321	326	330	334	339	343	348	352	356	361	365	370	374	378	383	387	392	396	400	405	409	414	418	422	427	431	436	440	444	449	453	458	462	466	471	475	480	484	488	493	497	502	506	510	515	519	524	528	0.88
0.87	261	265	270	274	278	283	287	291	296	300	305	309	313	318	322	326	331	335	339	344	348	352	357	361	365	370	374	378	383	387	392	396	400	405	409	413	418	422	426	431	435	439	444	448	452	457	461	465	470	474	479	483	487	492	496	500	505	509	513	518	522	0.87
0.86	258	262	267	271	275	280	284	288	292	297	301	305	310	314	318	323	327	331	335	340	344	348	353	357	361	366	370	374	378	383	387	391	396	400	404	409	413	417	421	426	430	434	439	443	447	452	456	460	464	469	473	477	482	486	490	495	499	503	507	512	516	0.86
0.85	255	259	264	268	272	276	281	285	289	293	298	302	306	310	315	319	323	327	332	336	340	344	349	353	357	361	366	370	374	378	383	387	391	395	400	404	408	412	417	421	425	429	434	438	442	446	451	455	459	463	468	472	476	480	485	489	493	497	502	505	510	0.85
0.84	252	256	260	265	269	273	277	281	286	290	294	298	302	307	311	315	319	323	328	332	336	340	344	349	353	357	361	365	370	374	378	382	386	391	395	399	403	407	412	416	420	424	428	433	437	441	445	449	454	458	462	466	470	475	479	483	487	491	496	500	504	0.84
0.83	249	253	257	261	266	270	274	278	282	286	291	295	299	303	307	311	315	320	324	328	332	336	340	344	349	353	357	361	365	369	374	378	382	386	390	394	398	403	407	411	415	419	423	427	432	436	440	444	448	452	457	461	465	469	473	477	481	486	490	494	498	0.83
0.82	246	250	254	258	262	267	271	275	279	283	287	291	295	299	303	308	312	316	320	324	328	332	336	340	344	349	353	357	361	365	369	373	377	381	385	390	394	398	402	406	410	414	418	422	426	431	435	439	443	447	451	455	459	463	467	472	476	480	484	488	492	0.82
0.81	243	247	251	255	259	263	267	271	275	279	284	288	292	296	300	304	308	312	316	320	324	328	332	336	340	344	348	352	356	360	365	369	373	377	381	385	389	393	397	401	405	409	413	417	421	425	429	433	437	441	446	450	454	458	462	466	470	474	478	482	486	0.81
0.80	240	244	248	252	256	260	264	268	272	276	280	284	288	292	296	300	304	308	312	316	320	324	328	332	336	340	344	348	352	356	360	364	368	372	376	380	384	388	392	396	400	404	408	412	416	420	424	428	432	436	440	444	448	452	456	460	464	468	472	476	480	0.80
0.79	237	241	245	249	253	257	261	265	269	273	277	280	284	288	292	296	300	304	308	312	316	320	324	328	332	336	340	344	348	352	356	359	363	367	371	375	379	383	387	391	395	399	403	407	411	415	419	423	427	431	435	438	442	446	450	454	458	462	466	470	474	0.79
0.78	234	238	242	246	250	254	257	261	265	269	273	277	281	285	289	293	296	300	304	308	312	316	320	324	328	332	335	340	343	347	351	355	359	363	367	371	374	378	382	386	390	394	398	402	406	410	413	417	421	425	429	433	437	441	445	449	452	456	460	464	468	0.78
0.77	231	234	239	243	246	250	254	258	262	266	270	273	277	281	285	289	293	296	300	304	308	312	316	320	323	327	331	335	339	343	347	350	354	358	362	366	370	373	377	381	385	389	393	397	400	404	408	412	416	420	424	427	431	435	439	443	447	450	454	458	462	0.77
0.76	228	232	236	239	243	247	251	255	258	262	266	270	274	277	281	285	289	293	296	300	304	308	312	315	319	323	327	331	334	338	342	346	350	353	357	361	365	369	372	376	380	384	388	391	395	399	403	407	410	414	418	422	426	429	433	437	441	445	448	452	456	0.76
0.75	225	229	233	236	240	244	248	251	255	259	263	266	270	274	278	281	285	289	293	296	300	304	308	311	315	319	323	326	330	334	338	341	345	349	353	356	360	364	368	371	375	379	383	386	390	394	398	401	405	409	413	416	420	424	428	431	435	439	443	446	450	0.75
0.74	222	226	229	233	237	241	244	248	252	255	259	263	266	270	274	278	281	285	289	292	296	300	303	307	311	315	318	322	326	329	333	337	340	344	348	352	355	359	363	366	370	374	377	381	385	389	392	396	400	403	407	411	414	418	422	426	429	433	437	440	444	0.74
0.73	219	223	226	230	234	237	241	245	248	252	256	259	263	266	270	274	277	281	285	288	292	296	299	303	307	310	314	318	321	325	329	332	336	339	343	347	350	354	358	361	365	369	372	376	380	383	387	391	394	398	402	405	409	412	416	420	423	427	431	434	438	0.73
0.72	216	220	223	227	230	234	238	241	245	248	252	256	259	263	266	270	274	277	281	284	288	292	295	299	302	306	310	313	317	320	324	328	331	335	338	342	346	349	353	356	360	364	367	371	374	378	382	385	389	392	396	400	403	407	410	414	418	421	425	428	432	0.72
0.71	213	217	220	224	227	231	234	238	241	245	249	252	256	259	263	266	270	273	277	280	284	288	291	295	298	302	305	309	312	316	320	323	327	330	334	337	341	344	348	351	355	359	362	366	369	373	376	380	383	387	391	394	398	401	405	408	412	415	419	422	426	0.71
0.70	210	214	217	221	224	228	231	235	238	242	245	249	252	256	259	263	266	270	273	277	280	284	287	291	294	298	301	305	308	312	315	319	322	326	329	333	336	340	343	347	350	354	357	361	364	368	371	375	378	382	385	389	392	396	399	403	406	410	413	417	420	0.70
0.69	207	210	214	217	221	224	228	231	235	238	242	245	249	252	255	259	262	266	269	273	276	279	283	286	290	293	297	300	304	307	311	314	317	321	324	328	331	335	338	342	345	348	352	355	359	362	366	369	373	376	380	383	386	390	393	397	400	404	407	411	414	0.69
0.68	204	207	211	214	218	221	224	229	231	235	238	241	245	248	252	255	258	262	265	269	272	275	279	282	286	289	292	296	299	303	306	309	313	316	320	323	326	330	333	337	340	343	347	350	354	357	360	364	367	371	374	377	381	384	388	391	394	398	401	405	408	0.68
0.67	201	204	208	211	214	218	221	224	229	231	235	239	241	245	248	251	255	258	261	265	268	271	275	278	281	285	288	291	295	298	302	305	308	312	315	318	322	325	328	332	335	338	342	345	348	352	355	358	362	365	369	372	375	379	382	385	389	392	395	399	402	0.67
0.66	198	201	205	208	211	215	218	221	224	228	231	234	238	241	244	248	251	254	257	261	264	267	271	274	277	281	284	287	290	294	297	300	304	307	310	314	317	320	323	327	330	333	337	340	343	347	350	353	356	360	363	366	370	373	376	380	383	386	389	393	396	0.66
0.65	195	198	202	205	208	211	215	218	221	224	228	231	234	237	241	244	247	250	254	257	260	263	267	270	273	276	280	283	287	289	293	296	299	302	306	309	312	315	319	322	325	328	332	335	338	341	345	348	351	354	358	361	364	367	371	374	377	380	384	387	390	0.65
0.64	192	195	198	202	205	208	211	214	218	221	224	227	230	234	237	240	243	246	250	253	256	259	262	266	269	272	275	278	283	285	288	291	294	298	301	304	307	310	314	317	320	323	326	330	333	336	339	342	346	349	352	355	358	362	365	368	371	374	378	381	384	0.64
0.63	189	192	195	198	202	205	208	211	214	217	221	224	227	230	233	236	239	243	246	249	252	255	258	261	265	268	271	274	277	280	284	287	290	293	296	299	302	306	308	312	315	318	321	324	328	331	334	337	340	343	347	350	353	356	359	362	365	369	372	375	378	0.63
0.62	186	189	192	195	198	202	205	208	211	214	217	220	223	226	229	233	236	239	242	245	248	251	254	257	260	264	267	270	273	276	279	282	285	288	291	295	298	301	304	307	310	313	316	319	322	326	329	332	335	338	341	344	347	350	353	357	360	363	366	369	372	0.62
0.61	183	186	189	192	195	198	201	204	207	210	214	217	220	223	226	229	232	235	238	241	244	247	250	253	256	259	262	265	268	271	275	278	281	284	287	290	293	296	299	302	305	308	311	314	317	320	323	326	329	332	336	339	342	345	348	351	354	357	360	363	366	0.61
0.60	180	183	186	189	192	195	198	201	204	207	210	213	216	219	222	225	228	231	234	237	240	243	246	249	252	255	258	261	264	267	270	273	276	279	282	285	288	291	294	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348	351	354	357	360	0.60
	300	305	310	315	320	325	330	335	340	345	350	355	360	365	370	375	380	385	390	395	400	405	410	415	420	425	430	435	440	445	450	455	460	465	470	475	480	485	490	495	500	505	510	515	520	525	530	535	540	545	550	555	560	565	570	575	580	585	590	595	600	

G2022

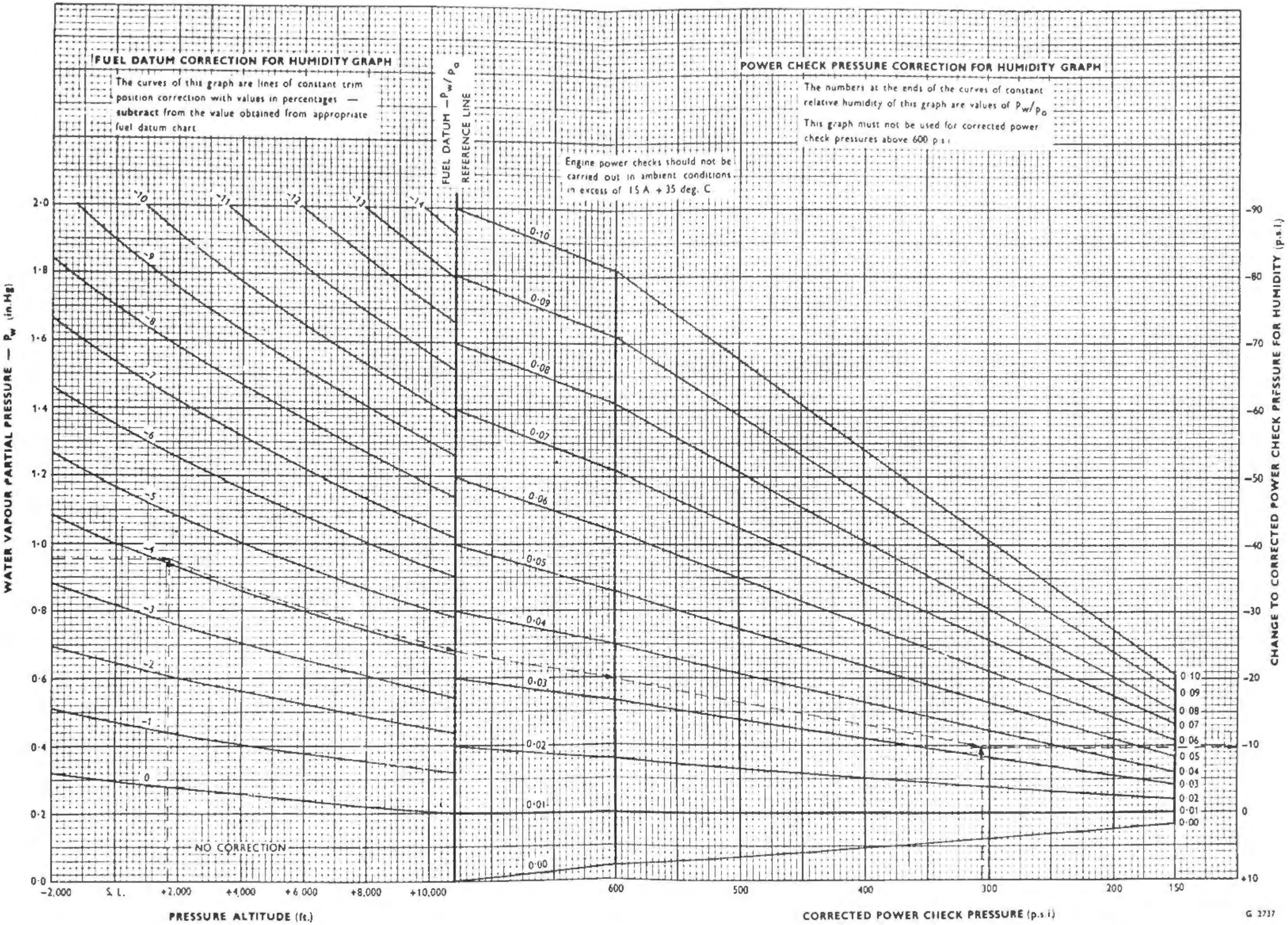
NOTE: Graphical representations of this table are shown in Fig.4-49(full range) and Fig.4-50(reduced range).

Corrections to Power Check Pressure - tabular
Figure 4-52



Hygrometric chart - graphical
Figure 4-53

NOTE: A tabular representation of this graph is shown in Fig.4-55.



Fuel datum corrections for humidity and change to corrected Power Check Pressure for humidity - graphical
Figure 4-54

NOTE: A tabular representation of this graph is shown in Fig. 4-56, 4-57 and 4-58.

HYGROMETRIC CHART

DRY BULB TEMPERATURE - T_o (deg.C.)

	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	+12	+13	+14	+15	+16	+17	+18	+19	+20	+21	+22	+23	+24	+25	+26	+27	+28	+29	+30	+31	+32	+33	+34	+35	+36	+37	+38
+50																																0.05	0.12	0.19	0.27	0.35	0.43	0.51	0.60	0.68	0.78	0.88	0.98	1.08					
+49																															0.01	0.07	0.15	0.22	0.29	0.37	0.45	0.53	0.62	0.71	0.80	0.90	1.00	1.11					
+48																															0.03	0.10	0.17	0.24	0.32	0.39	0.47	0.56	0.64	0.74	0.83	0.92	1.03	1.13					
+47																															0.05	0.12	0.19	0.26	0.34	0.42	0.50	0.58	0.67	0.76	0.85	0.95	1.05	1.16	1.26	1.38	1.49	1.42	1.75
+46																														0.01	0.08	0.15	0.22	0.29	0.36	0.44	0.52	0.61	0.69	0.78	0.87	0.97	1.08	1.18	1.29	1.40	1.52	1.64	1.77
+45																														0.04	1.10	0.17	0.24	0.31	0.38	0.46	0.54	0.63	0.72	0.81	0.90	1.00	1.10	1.20	1.31	1.42	1.54	1.67	1.79
+44																														0.06	0.12	0.19	0.26	0.33	0.41	0.49	0.57	0.65	0.74	0.83	0.92	1.02	1.12	1.23	1.34	1.45	1.57	1.69	1.82
+43																													0.02	0.08	0.15	0.22	0.28	0.36	0.43	0.51	0.59	0.68	0.76	0.85	0.95	1.04	1.15	1.25	1.36	1.47	1.59	1.71	1.84
+42																													0.04	0.11	0.17	0.24	0.31	0.38	0.46	0.53	0.61	0.70	0.79	0.88	0.97	1.07	1.17	1.27	1.38	1.49	1.61	1.74	1.86
+41																												0.01	0.07	0.13	0.20	0.26	0.33	0.41	0.48	0.56	0.64	0.72	0.81	0.90	0.99	1.09	0.19	1.30	1.41	1.52	1.64	1.76	1.89
+40																												0.03	0.09	0.15	0.22	0.29	0.35	0.43	0.50	0.58	0.66	0.75	0.84	0.92	1.02	1.11	1.22	1.32	1.43	1.54	1.66	1.78	1.91
+39																												0.05	0.11	0.18	0.24	0.31	0.38	0.45	0.53	0.61	0.69	0.77	0.86	0.95	1.04	1.14	1.24	1.34	1.45	1.57	1.68	1.81	1.93
+38																											0.02	0.08	0.14	0.20	0.27	0.33	0.40	0.48	0.55	0.63	0.71	0.79	0.88	0.97	1.06	1.16	1.26	1.37	1.48	1.59	1.71	1.83	1.96
+37																											0.04	0.10	0.16	0.22	0.29	0.36	0.43	0.50	0.57	0.65	0.73	0.82	0.90	1.00	1.09	1.18	1.29	1.39	1.50	1.61	1.73	1.85	
+36																										0.01	0.07	0.12	0.18	0.25	0.31	0.38	0.45	0.52	0.60	0.68	0.76	0.84	0.93	1.02	1.11	1.21	1.31	1.41	1.52	1.64	1.75		
+35																										0.03	0.09	0.15	0.21	0.27	0.34	0.41	0.47	0.55	0.62	0.70	0.78	0.87	0.95	1.04	1.13	1.23	1.34	1.44	1.55	1.66			
+34																										0.06	0.11	0.17	0.23	0.30	0.36	0.43	0.50	0.57	0.64	0.72	0.80	0.89	0.97	1.07	1.16	1.26	1.36	1.46	1.57				
+33																									0.02	0.08	0.14	0.20	0.25	0.32	0.38	0.45	0.52	0.59	0.67	0.75	0.83	0.91	1.00	1.09	1.18	1.28	1.38	1.49					
+32																									0.05	0.10	0.16	0.22	0.28	0.34	0.41	0.48	0.54	0.62	0.69	0.77	0.85	0.94	1.02	1.11	1.21	1.30	1.40						
+31																								0.02	0.07	0.13	0.18	0.24	0.30	0.37	0.43	0.50	0.57	0.64	0.72	0.79	0.87	0.96	1.05	1.14	1.23	1.33							
+30																								0.04	0.09	0.15	0.21	0.27	0.33	0.39	0.46	0.52	0.59	0.66	0.74	0.82	0.90	0.98	1.07	1.16	1.25								
+29																							0.01	0.07	0.12	0.17	0.23	0.29	0.35	0.41	0.48	0.55	0.61	0.69	0.76	0.84	0.92	1.00	1.09	1.18									
+28																							0.04	0.09	0.14	0.20	0.25	0.31	0.37	0.44	0.50	0.57	0.64	0.71	0.79	0.87	0.95	1.03	1.12										
+27																						0.01	0.06	0.11	0.17	0.23	0.28	0.34	0.40	0.46	0.53	0.59	0.66	0.74	0.81	0.89	0.97	1.05											
+26																						0.03	0.08	0.14	0.19	0.25	0.30	0.36	0.42	0.48	0.55	0.62	0.69	0.76	0.83	0.91	0.99												
+25																					0.01	0.06	0.11	0.16	0.21	0.27	0.33	0.38	0.44	0.51	0.57	0.64	0.71	0.78	0.86	0.94													
+24																					0.03	0.09	0.13	0.18	0.24	0.29	0.35	0.41	0.47	0.53	0.60	0.66	0.73	0.81	0.88														
+23																				0.01	0.06	0.10	0.15	0.21	0.26	0.32	0.37	0.43	0.49	0.56	0.62	0.69	0.76	0.83															
+22																				0.03	0.08	0.13	0.18	0.23	0.28	0.34	0.40	0.46	0.51	0.58	0.64	0.71	0.78																
+21																			0.01	0.06	0.10	0.15	0.20	0.25	0.31	0.36	0.42	0.48	0.54	0.60	0.67	0.74																	
+20																			0.03	0.08	0.13	0.17	0.22	0.28	0.33	0.38	0.44	0.50	0.56	0.63	0.70																		
+19																		0.01	0.06	0.10	0.15	0.20	0.25	0.30	0.35	0.41	0.47	0.53	0.59	0.65																			
+18																		0.04	0.08	0.13	0.17	0.22	0.27	0.33	0.38	0.43	0.49	0.55	0.61																				
+17																	0.02	0.06	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.46	0.51	0.57																					
+16																	0.04	0.08	0.13	0.17	0.22	0.27	0.32	0.37	0.43	0.48	0.54																						
+15																0.02	0.07	0.11	0.15	0.20	0.25	0.29	0.34	0.40	0.45	0.50																							
+14																0.04	0.09	0.13	0.17	0.22	0.27	0.32	0.37	0.42	0.47																								
+13															0.03	0.07	0.11	0.15	0.20	0.25	0.29	0.34	0.39	0.44																									
+12														0.01	0.05	0.09	0.14	0.18	0.22	0.27	0.32	0.36	0.41																										
+11														0.04	0.07	0.12	0.16	0.20	0.25	0.29	0.34	0.39																											
+10													0.02	0.06	0.10	0.14	0.18	0.22	0.27	0.32	0.36																												
+9												0.01	0.04	0.08	0.12	0.16	0.20	0.25	0.29	0.34																													
+8												0.03	0.07	0.11	0.15	0.19	0.23	0.27	0.32																														
+7											0.02	0.05	0.09	0.13	0.17	0.21	0.25	0.30																															
+6										0.02	0.04	0.08	0.12	0.15	0.19	0.23	0.28																																
+5										0.04	0.06	0.10	0.14	0.18	0.22	0.26																																	
+4									0.03	0.06	0.09	0.12	0.16	0.20	0.24																																		
+3								0.01	0.05	0.08	0.11	0.15	0.19	0.22																																			
+2								0.03	0.07	0.10	0.13	0.17	0.21																																				
+1							0.02	0.06	0.09	0.12	0.18	0.20																																					
0						0.01	0.04	0.08	0.11	0.15	0.18																																						
-1						0.03	0.07	0.10	0.13	0.17																																							
-2					0.02	0.06	0.09	0.12	0.15																																								
-3				0.02	0.04	0.08	0.11	0.14																																									
-4			0.01	0.04	0.07	0.10	0.13																																										
-5			0.03	0.06	0.09	0.12																																											
-6		0.02	0.05	0.08	0.11																																												
-7	0.01	0.04	0.07	0.10																																													
-8	0.04	0.06	0.09																																														
-9	0.06	0.08																																															
-10	0.08																																																

WET BULB TEMPERATURE - T_w (deg.C.)

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Hygrometric chart - tabular
Figure 4-55

NOTE: A graphical representation of this table is shown in Fig.4-53.

FUEL DATUM CORRECTIONS FOR HUMIDITY TABLE

WATER VAPOUR PARTIAL PRESSURE – P_w (in. Hg.)	-1,000	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	WATER VAPOUR PARTIAL PRESSURE – P_w (in Hg.)
2.00	- 9	-10	-10	-10	-11	-11	-12	-12	-12	-12	-13	-14	2.00
1.90	- 9	- 9	- 9	-10	-10	-11	-11	-11	-12	-12	-13	-13	1.90
1.80	- 8	- 8	- 9	- 9	-10	-10	-10	-11	-11	-12	-12	-13	1.80
1.70	- 8	- 8	- 8	- 9	- 9	- 9	-10	-10	-11	-11	-11	-12	1.70
1.60	- 7	- 7	- 8	- 8	- 8	- 9	- 9	-10	-10	-10	-11	-11	1.60
1.50	- 7	- 7	- 7	- 7	- 8	- 8	- 9	- 9	- 9	-10	-10	-11	1.50
1.40	- 6	- 6	- 7	- 7	- 7	- 8	- 8	- 8	- 9	- 9	- 9	-10	1.40
1.30	- 6	- 6	- 6	- 6	- 7	- 7	- 7	- 8	- 8	- 8	- 9	- 9	1.30
1.20	- 5	- 5	- 5	- 6	- 6	- 6	- 7	- 7	- 7	- 7	- 8	- 8	1.20
1.10	- 4	- 5	- 5	- 5	- 5	- 6	- 6	- 6	- 6	- 7	- 7	- 7	1.10
1.00	- 4	- 4	- 4	- 4	- 5	- 5	- 5	- 5	- 6	- 6	- 6	- 7	1.00
0.90	- 3	- 3	- 4	- 4	- 4	- 4	- 5	- 5	- 5	- 5	- 5	- 6	0.90
0.80	- 3	- 3	- 3	- 3	- 3	- 4	- 4	- 4	- 4	- 4	- 5	- 5	0.80
0.70	- 2	- 2	- 2	- 3	- 3	- 3	- 3	- 3	- 4	- 4	- 4	- 4	0.70
0.60	- 2	- 2	- 2	- 2	- 2	- 2	- 2	- 3	- 3	- 3	- 3	- 3	0.60
0.50	- 1	- 1	- 1	- 1	- 2	- 2	- 2	- 2	- 2	- 2	- 2	- 2	0.50
0.40	0	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 1	- 2	- 2	0.40
0.30		0	0	0	0	0	0	0	- 1	- 1	- 1	- 1	0.30
0.20									0	0	0	0	0.20
0.10					NO CORRECTION								0.10
0.00													0.00

PRESSURE ALTITUDE (ft.)

G2090

Fuel datum corrections for humidity - tabular
Figure 4-56

NOTE: A graphical representation of this table is shown in Fig. 4-54.

RELATIVE HUMIDITY (P_W/P_O) FACTOR TABLE

WATER VAPOUR PARTIAL PRESSURE - P_w (in. Hg.)	-1,000	- 500	S.L.	+ 500	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	WATER VAPOUR PARTIAL PRESSURE - P_w (in. Hg.)
2.00	0.064	0.065	0.067	0.068	0.069	0.072	0.074	0.077	0.080	0.083	0.086	0.090	0.093	0.097	2.00
1.90	0.061	0.062	0.063	0.064	0.066	0.068	0.071	0.073	0.076	0.079	0.082	0.085	0.089	0.092	1.90
1.80	0.058	0.059	0.060	0.061	0.062	0.065	0.067	0.069	0.072	0.075	0.078	0.081	0.084	0.087	1.80
1.70	0.055	0.056	0.057	0.058	0.059	0.061	0.063	0.066	0.068	0.071	0.073	0.076	0.079	0.082	1.70
1.60	0.051	0.052	0.053	0.054	0.055	0.057	0.060	0.062	0.064	0.067	0.069	0.072	0.075	0.078	1.60
1.50	0.048	0.049	0.050	0.051	0.052	0.054	0.056	0.058	0.060	0.062	0.065	0.067	0.070	0.073	1.50
1.40	0.045	0.046	0.047	0.048	0.048	0.050	0.052	0.054	0.056	0.058	0.060	0.063	0.065	0.068	1.40
1.30	0.042	0.043	0.044	0.044	0.045	0.047	0.048	0.050	0.052	0.054	0.056	0.058	0.061	0.063	1.30
1.20	0.039	0.040	0.041	0.041	0.041	0.043	0.045	0.046	0.048	0.050	0.052	0.054	0.056	0.058	1.20
1.10	0.035	0.036	0.037	0.037	0.038	0.039	0.041	0.042	0.044	0.046	0.048	0.049	0.051	0.053	1.10
1.00	0.032	0.033	0.033	0.034	0.035	0.036	0.037	0.039	0.040	0.042	0.043	0.045	0.047	0.048	1.00
0.90	0.029	0.029	0.030	0.031	0.031	0.032	0.033	0.035	0.036	0.037	0.039	0.040	0.042	0.044	0.90
0.80	0.026	0.026	0.027	0.027	0.028	0.029	0.030	0.031	0.032	0.033	0.035	0.036	0.037	0.039	0.80
0.70	0.023	0.023	0.023	0.024	0.024	0.025	0.026	0.027	0.028	0.029	0.030	0.031	0.033	0.034	0.70
0.60	0.019	0.019	0.020	0.020	0.021	0.022	0.022	0.023	0.024	0.025	0.026	0.027	0.028	0.029	0.60
0.50	0.016	0.016	0.017	0.017	0.017	0.018	0.019	0.019	0.020	0.021	0.022	0.022	0.023	0.024	0.50
0.40	0.013	0.013	0.013	0.014	0.014	0.014	0.015	0.015	0.016	0.017	0.017	0.018	0.019	0.019	0.40
0.30	0.010	0.010	0.010	0.010	0.010	0.011	0.011	0.012	0.012	0.012	0.013	0.013	0.014	0.015	0.30
0.20	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.009	0.009	0.009	0.010	0.20
0.10	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.10
0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00

PRESSURE ALTITUDE (ft.)

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Relative humidity factors - tabular
Figure 4-57

NOTE: A graphical representation of this table is shown in Fig. 4-54

CHANGE TO CORRECTED POWER CHECK PRESSURE FOR HUMIDITY TABLE

RELATIVE HUMIDITY – P_w/P_o	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520	540	560	580	600	RELATIVE HUMIDITY – P_w/P_o
0.100	-27	-30	-32	-35	-38	-40	-43	-46	-48	-51	-54	-56	-59	-62	-64	-67	-70	-73	-75	-78	-81	0.100
0.095	-25	-28	-30	-33	-35	-38	-40	-43	-45	-48	-50	-53	-55	-58	-60	-63	-65	-68	-71	-73	-76	0.095
0.090	-24	-26	-28	-31	-33	-35	-38	-40	-42	-45	-47	-49	-52	-54	-56	-59	-61	-64	-66	-68	-71	0.090
0.085	-22	-24	-26	-28	-31	-33	-35	-37	-39	-42	-44	-46	-48	-50	-53	-55	-57	-59	-61	-64	-66	0.085
0.080	-20	-22	-24	-26	-28	-30	-32	-34	-37	-39	-41	-43	-45	-47	-49	-51	-53	-55	-57	-59	-61	0.080
0.075	-19	-21	-22	-24	-26	-28	-30	-32	-34	-36	-37	-39	-41	-43	-45	-47	-49	-51	-52	-54	-56	0.075
0.070	-17	-19	-21	-22	-24	-26	-27	-29	-31	-33	-34	-36	-38	-39	-41	-43	-45	-46	-48	-50	-51	0.070
0.065	-16	-17	-19	-20	-22	-23	-25	-27	-28	-30	-31	-33	-34	-36	-37	-39	-41	-42	-44	-45	-47	0.065
0.060	-14	-15	-17	-18	-20	-21	-23	-24	-25	-27	-28	-30	-31	-32	-34	-35	-37	-38	-39	-41	-42	0.060
0.055	-13	-14	-15	-16	-18	-19	-20	-21	-23	-24	-25	-26	-28	-29	-30	-31	-33	-34	-35	-37	-38	0.055
0.050	-11	-12	-13	-14	-16	-17	-18	-19	-20	-21	-22	-23	-25	-26	-27	-28	-29	-30	-31	-32	-33	0.050
0.045	-10	-11	-12	-13	-14	-14	-15	-16	-17	-18	-19	-20	-21	-22	-23	-24	-25	-26	-27	-28	-29	0.045
0.040	- 8	- 9	-10	-11	-12	-12	-13	-14	-15	-16	-16	-17	-18	-19	-20	-21	-21	-22	-23	-24	-25	0.040
0.035	- 7	- 7	- 8	- 9	-10	-10	-11	-12	-12	-13	-14	-14	-15	-16	-16	-17	-18	-18	-19	-20	-20	0.035
0.030	- 5	- 6	- 6	- 7	- 8	- 8	- 9	- 9	-10	-10	-11	-11	-12	-12	-13	-14	-14	-15	-15	-16	-16	0.030
0.025	- 4	- 4	- 5	- 5	- 6	- 6	- 6	- 7	- 7	- 8	- 8	- 8	- 9	- 9	-10	-10	-10	-11	-11	-12	-12	0.025
0.020	- 3	- 3	- 3	- 3	- 4	- 4	- 4	- 4	- 5	- 5	- 5	- 5	- 6	- 6	- 6	- 7	- 7	- 7	- 7	- 8	- 8	0.020
0.015	- 1	- 1	- 2	- 2	- 2	- 2	- 2	- 2	- 2	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 3	- 4	- 4	- 4	- 4	0.015
0.010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.010
0.005	+ 1	+ 1	+ 2	+ 2	+ 2	+ 2	+ 2	+ 2	+ 2	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 3	+ 4	+ 4	+ 4	+ 4	0.005
0.000	+ 3	+ 3	+ 3	+ 3	+ 4	+ 4	+ 4	+ 4	+ 5	+ 5	+ 5	+ 5	+ 6	+ 6	+ 6	+ 6	+ 6	+ 7	+ 7	+ 8	+ 8	0.000

CORRECTED POWER CHECK PRESSURE (p.s.i.)

G2092A

Change to corrected Power Check Pressure for humidity - tabular
Figure 4-58

NOTE: A graphical representation of this graph is shown in Fig. 4-54.

Reserved

4.9.6 Engine Starting and Run-up Procedures

4.9.6.1 External Check

1. Area & Equipment ....CLEAR

2. Chock ....CHECK

3. Ground Fire Extinguisher ....READY

4. Landing Gear Safety Pin ....IN

5. Aircraft Position ....CHECK (Cross Wind ± 30°)

6. Nose L/G Bay
    - (1) Nose L/G & Door ....CHECK
    - (2) Torque Arm Pin ....CONNECTED
    - (3) Tire & Oleo ....CHECK

7. Front Fuselage
    - (4) Access Door ....LOCKED
    - (5) Pitot Tube & Cover ....CHECK
    - (6) Static Pressure Port ....CLEAR
    - (7) Antennas & Anticollision Light ....CHECK

8. R/H. Nacelle & Propeller
    - (8) Engine Air Intake Cowling ....CHECK & NO COVER
    - (9) Propeller Blade ....CHECK
    - (10) Propeller Angle ...."0" DEGREE
    - (11) Propeller Rotation ....FREE
    - (12) Fire Extinguisher Indicator ....CHECK (Green)
    - (13) Engine Cowling.....................SECURE
    - (14) Engine Exhaust Pipe ....CHECK & NO COVER
    - (15) Fuel & Oil Leak ....NO LEAK

9. R/H. Main Wheel Well
    - (16) Main L/G & Door ....CHECK
    - (17) Tire & Oleo ....CHECK
    - (18) Wing De-ice Fire Extinguisher Indicator ....CHECK (Yellow)

10. R/H. Wing
    - (19) Wing Heater Inlet Duct ....CHECK
    - (20) Wing Leading Edge ....CHECK
    - (21) Wing Lower Surface ....CHECK & NO FUEL LEAKAGE
    - (22) Navigation Light ....CHECK
    - (23) Static Discharger ....CHECK
    - (24) Aileron & Tab ....CHECK NEUTRAL
    - (25) Flaps ....CHECK (Up)

11. Horizontal & Vertical Tail
    - (26) Stabilizer & Vortex Generator .....CHECK
    - (27) Elevator & Tabs ....NEUTRAL
    - (28) Vertical Stabilizer ....CHECK

(29) Rudder & Tab .... NEUTRAL
(30) Antennas .... CHECK
(31) Tail Navigation Light .... CHECK

12. L/H. Nacelle & Propeller
(32) Engine Air Intake Cowling .... CHECK & NO COVER
(33) Propeller Blade .... CHECK
(34) Propeller Angle .... "0" DEGREE
(35) Propeller Rotation .... FREE
(36) Fire Extinguisher Indicator .... CHECK (Green)
(37) Engine Cowling .... SECURE & NO COVER
(38) Engine Exhaust Pipe .... CHECK & NO COVER
(39) Fuel & Oil Leak .... NO LEAK

13. L/H. Wing
(40) Wing Heater Inlet Duct .... CHECK
(41) Wing Leading Edge .... CHECK
(42) Wing Lower Surface .... CHECK & NO FUEL, W/M LEAK
(43) Navigation Light .... CHECK
(44) Static Discharger .... CHECK
(45) Aileron & Tab .... CHECK NEUTRAL
(46) Flaps .... CHECK (Up)

14. Prepare records and engine data necessary for the engine run up.

4.9.6.2 Cockpit Check

4.9.6.2.1 Before Starting Check (External Power Off)

1. Circuit Breaker Panels .... 3 PANELS CHECK

2. Battery Sw .... OFF

3. Windshield De-ice Sw (LH, RH) .... OFF

4. Pitot Deicing Heater Sw .... OFF

5. Wing Tail De-ice & Ignition Select Sw(3). OFF

6. Ram Air Override Sw. .... NORMAL

7. Blower Sw .... OFF

8. Ignition Test Sw .... NORMAL

9. Aircraft De-icing Sw..................... OFF

10. Engine De-icing Master Sw.(Nos. 1&2)..... OFF

11. Radio Power Feed Master Sw. & Cooling Fan Sw. .... OFF

12. Generator Sw. (Nos. 1 & 2) .... OFF

13.	Scavenge Pump Sw. (Nos. 1 & 4)	OFF
14.	Booster Pump Sw. (Nos. 1 & 4, Main Emerg.)	OFF
15.	Crossfeed Valve Sw.	NORMAL
16.	Fuel De-icing Sw. (Nos. 1 & 2)	OFF
17.	Inverter Sw. (C.F. Power Source) Nos. 1 & 2, Emerg.	OFF
18.	Alternator Sw. (W.F. Power Source) Nos. 1 & 2	OFF
19.	W.F. Alternator Transfer Sw. Nos. 1 & 2	OFF
20.	Landing Light & Motor Sw.	OFF
21.	Taxi Light Sw.	OFF
22.	Wing Inspection Light Sw.	OFF
23.	Anti Collision Light Sw.	OFF
24.	Navigation Light Sw.	OFF
25.	Starter Master Sw.	SAFE
26.	Engine Selector Sw	OFF
27.	Ign. Relight Sw. (Nos. 1 & 2)	OFF
28.	Wing Fire Extinguisher Sw. (LW. Tail, RW)	OFF
29.	High Stop Sw.	NORMAL
30.	Emerg.Fuel Shut Off Handle (Nos. 1 & 2)	LOCK
31.	Fire Extinguisher Discharge Sw.	CHECK (Off)
32.	Propeller Brake Sw.	OFF
33.	Wiper Speed Control Knob	FULL CLOSE (C.W)
34.	Oxygen Supply Sw.	OFF
35.	Static Selector Sw. (2)	NORMAL
36.	Anti Skid Sw.	OFF
37.	Parking Brake Handle	PULL SET

38. Landing Gear Handle .... DOWN

39. Fuel Qty Test Selector Sw. (LH,RH). MAIN SELECTED

40. Emerg.Hyd. Pump Sw .... OFF

41. Emerg.L/G Handle .... LOCK

42. Cooling Fan Sw. .... OFF

43. Spill Valve Sw. (LH, RH) .... MANUAL

44. By-Pass Handle .... BY-PASS

45. Cockpit Temp.Selector Knob .... OFF

46. Emerg.Flap Handle .... LOCKED

47. Manual Cont.Knob .... FULL INC.

48. Press. Cont. Shut Off Sw. .... OPEN

49. Pitot Static Shut Off Valve .... NORMAL

50. All Trim Tabs (3) .... NEUTRAL CHECK

51. Prop. Synchro Sw. .... OFF

52. W/M Booster Pump Sw. .... OFF

53. W/M Master Sw. (LH, RH) .... OFF

54. Flap Cont. Sw. .... OFF

55. Gust Lock Lever .... LOCK

56. H.P. Cock Lever (Nos. 1 & 2) ...... OFF

57. Low Stop Lever .... GROUND

58. Throttle Lever (Nos. 1 & 2) .... FULL MIN

59. Friction Lock Lever .... UNLOCK

60. Emerg.Brake Handle .... NORMAL (Push)

61. Stewardess Circuit Panel Sw. ...... OFF

4.9.6.3 External Power On Check

1.	External Power	CONNECT
2.	Battery Sw.	EXTERNAL
3.	External Power I/C	ON
4.	DC Voltage	CHECK (28V ± 1V)
5.	Battery	24V
	(1) Emer. Shut off Valve Ind. (LH, RH)	OPEN
	(2) Fuel Cross Feed Ind. (LH,RH)	SHUT
	(3) Main Bus Fail W/L	ON
	(4) Alternator Fail W/L (Nos. 1 & 2)	ON
	(5) Power Fail W/L (Nos. 1 & 2)	ON
	(6) Fuel Press W/L (Nos. 1 & 2)	ON
	(7) Oil Press W/L (Nos. 1 & 2)	ON
	(8) Landing Gear I/L & Unlock I/L.	ON 3 GREEN & OFF
	(9) Low Stop Unsafe Light	ON
	(10) Below Low Stop Light (Nos. 1 & 2)	ON
	(11) Feathering Pump Light (Nos. 1 & 2)	OFF
	(12) High Stop Removed Light (Nos. 1 & 2)	OFF (Push to Test)
	(13) High Stop Unsafe Light	ON
	(14) High Stop Emerg. Sw.	CHECK NORMAL
6.	Inverter Sw. (Nos. 1 or 2)	ON
7.	Power Fail W/L (Nos. 1 & 2)	OFF
8.	Eng. Overheat Test Button (Nos. 1 & 2)	PUSH TO TEST
9.	Eng. Overheat (Nos. 1 & 2)	PUSH TO TEST
10.	L/G Fire W/L (Nos. 1 & 2)	PUSH TO TEST
11.	Engine Oil Temp. Ind.(Nos. 1&2)	CHECK
12.	Flap Position Ind.	UP
13.	Fuel Quantity, (Nos. 1 & 4)	CHECK (Min. 1000 lbs)
14.	W/M Qty Ind.	CHECK (Min. 40 USG)
15.	Hyd. Qty Ind.	CHECK (In Green Marks)

16. Hyd. Press. Normal .... CHECK (2100 psi above)
Emerg. .... CHECK (2400 psi above)

17. Emerg. Hyd. Press. Sw. .... NORMAL

18. Under Floor Door Open W/L .... OFF (Push to Test)

19. Cabin Door Open W/L .... OFF (Push to Test)

20. Spill Valve Light (LH, RH) .... ON

21. W/M Pressure Light (LH, RH) .... OFF

4.9.6.4 Starting Procedures

1. Door Warning Light .... OFF

2. Anti-collision Light .... ON

3. Fuel Trimmer Sw. .... O.A.T. SET

NOTE: Outside air temperature + 10°C above 10%
Outside air temperature + 10°C below 30%

4. Check Oil Temp. .... MIN. -30°C
(Minimum for Open Up -15°C)

5. H. P. Cock Lever .... OFF

6. Low Stop Lever .... GROUND

7. Throttle Lever .... FULL MIN.

8. Fuel Booster Pump .... ON

9. Fuel Pressure W/L .... OFF

10. Propeller Brake Sw. .... OFF
(After Stair Way Up)

11. Engine Selector Sw. .... #2 SELECT

12. Starter Master Sw. .... START

13. Propeller Stop .... CHECK

14. Check Fire Guard .... CLEAR

15. Starter Push Button .... 2 to 3 SEC. PUSH

16. Starter Motor I/L .... #2 ON

17. H.P Cock Lever .... H.S.W.D. (Lock Out)

When Engine Speed Reaches 1200 to 1500 rpm

18. High Stop Removed Light .... ON

19. Start T.G.T. .... WATCH NOT TO EXCEED 930°C

20. Oil Pressure W/L .... 5 to 6 psi OFF

21. Oil Pressure Gauge .... CHECK OFF
STOP

22. Start Push Button (After 30 Second) POP OUT
Starter Motor Indicator Light ..... OFF

23. Fuel Trimmer .... O.A.T. SET

CAUTION: DISCONTINUE THE ENGINE STARTING IMMEDIATELY (POSITIONING THE ENGINE SELECTOR SWITCH TO SAFE) AND PLACE THE H.P. COCK LEVER IN FUEL OFF IF ANY OF THE FOLLOWING CONDITIONS TAKES PLACE:

1. No light up within 20 seconds after initial indication of fuel flow
2. T.G.T. approaches 930°C
3. No oil pressure indication
4. No automatic acceleration to idle rpm
5. Unusual or excessive propeller vibration.

NOTE: If starting is discontinued, motor the engine for 30 second and allow the fuel drain collector can to drain fuel for 2 min.

6. Increase the trimmer gradually, watching the T.G.T. indicator in order to avoid abrupt rise of T.G.T.
7. If the starter motor indicator light remains on, place the starter master switch in SAFE.

24. No. 1 Engine Select Sw. .... SELECT
(No. 2 Engine in the Same Manner)

4.9.6.5 After Start

1. Starter Master Switch .... SAFE

2. Engine Selector Switch .... OFF

3. Generator Switch (Nos 1 & 2) ...... ON

4. External I/L .... OFF

5. D.C. Voltage .... CHECK (28V ± 1V)
& Battery Voltage .... CHECK

6. Battery Switch .... BATTERY

7. External Power Unit .... DISCONNECTED & CLEARED

8. Hyd. By-pass Lever .... NORMAL

9. Hyd. Pressure .... 2575 to 3200 psi

4.9.6.6 Engine Serviceability Check

4.9.6.6.1 Idling Check

1. Throttle Lever .... MIN. POSITION

2. Set Fuel Trimmer .... FULL INCREASE

3. Check and Record rpm .... CHECK & RECORD (8000 to 85000 RPM)

4. Check and Record Fuel Flow .... CHECK & RECORD (345± 8lb/HR)

4.9.6.6.2 12000 R.P.M. Check

1. Set Fuel Trimmer .... O.A.T. SET

2. Set Engine RPM .... 12000 RPM.

3. Oil Pressure and Oil Temperature . CHECK & RECORD

NOTE: Minimum Oil Temperature .... 55°C
Minimum Oil Press .... 13.5 psi at 55°C
12.0 psi at 115 to 120°C

4. Fuel Heater De-icing Check
   (1) Fuel Filter Heater Switch to Manual .... DECREASE 50~100 RPM
   (2) Fuel Filter Heater Switch to Off .... INCREASE 50~100 RPM

5. Power Unit Ice Protection System Check
   (1) Set Engine RPM 12000rpm
   (2) Alternator Switch .... START-ON
   (3) A.C. Voltage (144-156V) .... CHECK & RECORD
   (4) Engine De-icing Timer Switch ... FAST -15°C ABOVE
   SLOW -15°C BELOW

   (5) Engine De-icing Master Switch .. ON FOR 5 SECS-THEN OFF
   (6) Timer Fail I/L .... OFF
   (7) De-icing Fail I/L .... OFF
   (8) A.C. Ammeter .... CHECK/COMPLETE CYCLE
   0 ~20 Seconds ......30~35 Amps ... AIR INTAKE
   20~40 Seconds ......40~50 Amps ... PROPELLER & SPINNER
   40-60 Seconds ...... 7~10 Amps ... AIR INTAKE CONTINUOUS

WARNING: When the outside air temperature is above 30°C, do not conduct the power unit ice protection system check. Operation in excess of 6 cycles is also prohibited.

(9) Alternator Switch .... OFF

(10) Alternator Failure I/L .... ON

4.9.6.6.3 Dry Power Check

1. Set Fuel Trimmer .... AMBIENT SET

2. Check Oil Temperature .... AT LEAST 55°C

3. Advance Throttle .... SMOOTHLY
   Below Low Stop Light .... OUT

NOTE: Keep the throttle lever in FULL OPEN position for 1 min 30 sec. at least to stabilize T.G.T.

4. Check and Record
   (1) Engine RPM .... 15000~15050 RPM
   (2) T.G.T. .... NOT TO EXCEED 865°C
   (3) Torque Press. .... RECORD
   (4) Engine Oil Pressure .... AT LEAST 13.5 psi
   (5) Engine Oil Temperature .... 65°~ 75°C
   (6) Engine Fuel Flow .... RECORD

NOTE: 1. The maximum allowable T.G.T. while the throttle is in FULL OPEN position is 865°C.

2. Record the reading swiftly and accurately to minimize the engine ground run time at the maximum power condition.

(7) Retard Throttle Smoothly ...... BELOW LOW STOP LIGHT ON

4.9.6.6.4 Wet Power Check

1. Set Fuel Trimmer Ambient .... SET

2. Position Throttle .... MINIMUM

3. Check Oil Temperature .... AT LEAST 65°C

4. W/M Booster Pump Switch .... ON

5. W/M Master Sw. .... ON

6. W/M Pressure Indicator Light ...... ON

WARNING: Do not turn on the W/M booster pump switch and the W/M master switch at higher rpm (in excess of 14500 rpm).

7. Advance Throttle .... SMOOTHLY

NOTE: Advance the throttle lever smoothly up to 14000 rpm and, then, advance it slowly from 14000 rpm to 14700 rpm. Watching carefully the tachometer and the torque pressure indicator all the time, take a rest at 14700 rpm for 10 sec., then, advance to 14800 rpm and then, make sure that the torque pressure increases, watching the torque pressure indicator. Check that the W/M system cuts in at 14700 to 14900 rpm, increasing the torque pressure.

CAUTION: IF THE TORQUE PRESSURE DOES NOT INCREASE BEFORE THE ENGINE SPEED REACHES, CHECK THE SYSTEM.

8. After Increase in Torque Pressure, Advance Throttle to Take-off.

9. Check and Record Readings .... AT LEAST 60 SEC.

   (1) T.G.T. .... NOT EXCEED 890°C & RECORD
   (2) Torque Pressure .... CORRECTED DATA PLATE ..... RECORD WITHIN $^{+7}_{-0}$ PSI

CAUTION: 1. RECORD THE READING SWIFTLY AND ACCURATELY TO MINIMIZE THE ENGINE GROUND RUN TIME AT THE MAXIMUM POWER CONDITION.

2. WHEN THE THROTTLE IS RETARDED FROM THE FULL OPEN POSITION, TAKE AT LEAST 5 SEC BEFORE THE ENGINE SPEED REACHES 14500 RPM.

3. BE CAREFUL NOT TO RETARD THE THROTTLE ABRUPTLY, OTHERWISE THE T.G.T. MAY EXCEED 1000°C.

10. Retard Throttle to 14650 RPM ..... TAKING AT LEAST 15 SEC.
    Hold at 14650 RPM for 15 Sec. .... NO FALL IN TORQUE PRESSURE

11. W/M Cutout Check .... RECORD

12. W/M Booster Pump Switch .... OFF

13. W/M Master Switch .... OFF

14. W/M Pressure Indicator Light ..... OFF

15. Retard Throttle .... BELOW LOW STOP LIGHT ON

4.9.7 Engine Shut-Down Procedures

1. Low Stop Lever .... GROUND

2. Gust Lock Lever .... LOCK

3. Throttle Lever .... MINIMUM

4. Fuel Trimmer .... FULL DECREASE

5. H.P. Cock Lever .... FUEL OFF

6. Oil Pressure W/L .... ON

7. Propeller Brake Sw. .... ON BELOW 3000 RPM

8. D.C. Generator Sw. .... OFF

9. Inverter Sw. .... OFF

10. Fuel Booster Pump Sw. .... OFF

11. Anti Collision Light Sw. .... OFF

12. Battery Sw. .... OFF

13. Parking Brake .... CHECK

14. Cockpit Windows .... CLOSED

WARNING: 1. Do not turn on the propeller brake switch when the engine speed is above 3000 rpm.

2. Keep away from the engine exhaust pipe outlet for 5 min. after engine shut down because the residual fuel may be ignited.

3. Place the H.P. cock lever in Fuel OFF position positively. There is possibility of explosion at next starting if there is fuel leak in the engine after shut down.

4. When the H.P. cock lever is moved to OFF, cover the positions below OFF with a hand so that it can not be moved to the feather position inadvertently. If the H.P. cock lever is placed in the feather position, the propeller may be feathered by the remaining oil pressure.

4.9.8 Motoring Cycle Procedures

1. Blow Out (Dry Cycling)
    - (1) Propeller Pitch .... CHECK GROUND FINE PITCH
    - (2) Low Stop Lever .... GROUND
    - (3) H.P. Cock Lever .... FUEL OFF
    - (4) Fuel Booster Pump .... ON
    - (5) Fuel Pressure W/L .... OUT
    - (6) Relight Sw. .... OFF
    - (7) Engine Selector .... AS REQUIRED
    - (8) Starter Master Sw. .... BLOW OUT
    - (9) Propeller Stop .... CHECK
    - (10) Fire Guard .... CHECK
    - (11) Starter Button .... PUSH
    - (12) Starter Motor Ind. Light ..... CHECK ON
    - (13) Starter Master Sw. .... SAFE (After 30 sec. of Motoring)
    - (14) Starter Button & Ind. Light .. CHECK OUT
    - (15) Fuel Booster Pump .... OFF

CAUTION: 1. DO NOT EXCEED THE MAXIMUM ALLOWABLE DURATION OF 30 SEC. WHEN THE STARTER MOTOR IS USED FOR MOTORING CYCLE.

2. TAKE 15 MIN. REST AT LEAST AFTER 6 SUCCESSIVE STARTING CYCLES OR MOTORING CYCLES IN ORDER TO COOL THE STARTER MOTOR.

2. Blow Out (Wet Cycling)

(1) Take the same procedures as those for the "Dry Cycling." However, keep the H.P. cock lever in the high stop withdrawal for 20 sec. during the 30 sec. motoring cycle.

(2) Conduct the dry cycling after the wet cycling.

4.9.9 Fire during Start

1. Starter Master Sw. .... SAFE
2. H.P. Cock Lever .... FEATHER
3. Feathering Button .... PUSH
4. Emerg. Fuel Shut-off Handle ...... PULL
5. Fire-Extinguisher .... 1st SHOT
   (2nd Shot If Necessary)

NOTE: 1. If the other engine is running, feather it to facilitate fire fighting on the ground.

2. When an engine is feathered, pull the emergency fuel shut off handle as quickly as possible.

6. Propeller Feather Angle .... CHECK
7. Throttle Lever .... MIN.
8. Booster Pump .... OFF

4.9.10 Exhaust Pipe Fire

1. Throttle Lever .... MIN.
2. H.P. Cock Lever .... FUEL OFF
3. Ignition C/B .... OFF
4. Engine Selector Sw. .... AS REQUIRED
5. Starter Master Sw. .... BLOW-OUT
6. Starter Push Button .... PUSH

WARNING: After making sure that the propeller has completely stopped, push the starter push button.

7. Starter Master Sw. .... SAFE
   (After 30 Sec. of Motoring)

4.9.11 Landing Gear Well Fire

1. H.P. Cock Lever .... FEATHER
2. Feathering Button .... PUSH
   (Complete Feather .... CHECK)
3. Emerg. Fuel Shut off Handle ...... PULL
4. Fire Extinguisher Sw. .... 1st SHOT
5. Throttle Lever .... MIN.
6. Fuel Booster Pump .... OFF
   (2nd Shot if Necessary)

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NOTE: The aircraft YS-11 is equipped with turbo-prop engines designed to drive the propellers by gas turbines. The engine has fairly many differences from conventional reciprocating engines and even from similar turbo-prop engines of other manufacturers (e.g., Allison, Turboméca Astazon, etc.) in function and structure. Therefore, for purpose of giving an outline of Dart turbo-prop engines, a description thereof is given in the paragraphs 4.1 and 4.2.
Those who are familiar with this type of engine may skip these paragraphs.

4.1 General

The aircraft has two Rolls-Royce Dart R. Da 10 MK542 turbo-prop engines. The main components are a two-stage centrifugal compressor, seven combustion chambers, and a three-stage axial flow turbines. The compressor is directly coupled with the turbine; the propeller is driven by the turbine through a separate shaft and reduction gear.
The air coming in from the front of the engine enters the first-stage compressor for compression to increase its pressure and then the second-stage compressor for further compression. The compressed air flows from the compressor outlet casing into seven combustion chambers, where, together with the injected fuel, burns to suddenly expand into a tremendous volume of gas, rapidly flowing through the turbine. Most of the expanded gas flow is utilized to turn the turbine, driving the compressor and at the same time being transmitted to the propeller through the reduction gear to rotate the propeller. Energy not absorbed by the turbine flows inside the jet pipe, being ejected rearward to be utilized as a small amount of thrust. Also, to increase the engine power, the water/methanol injection can be carried out.

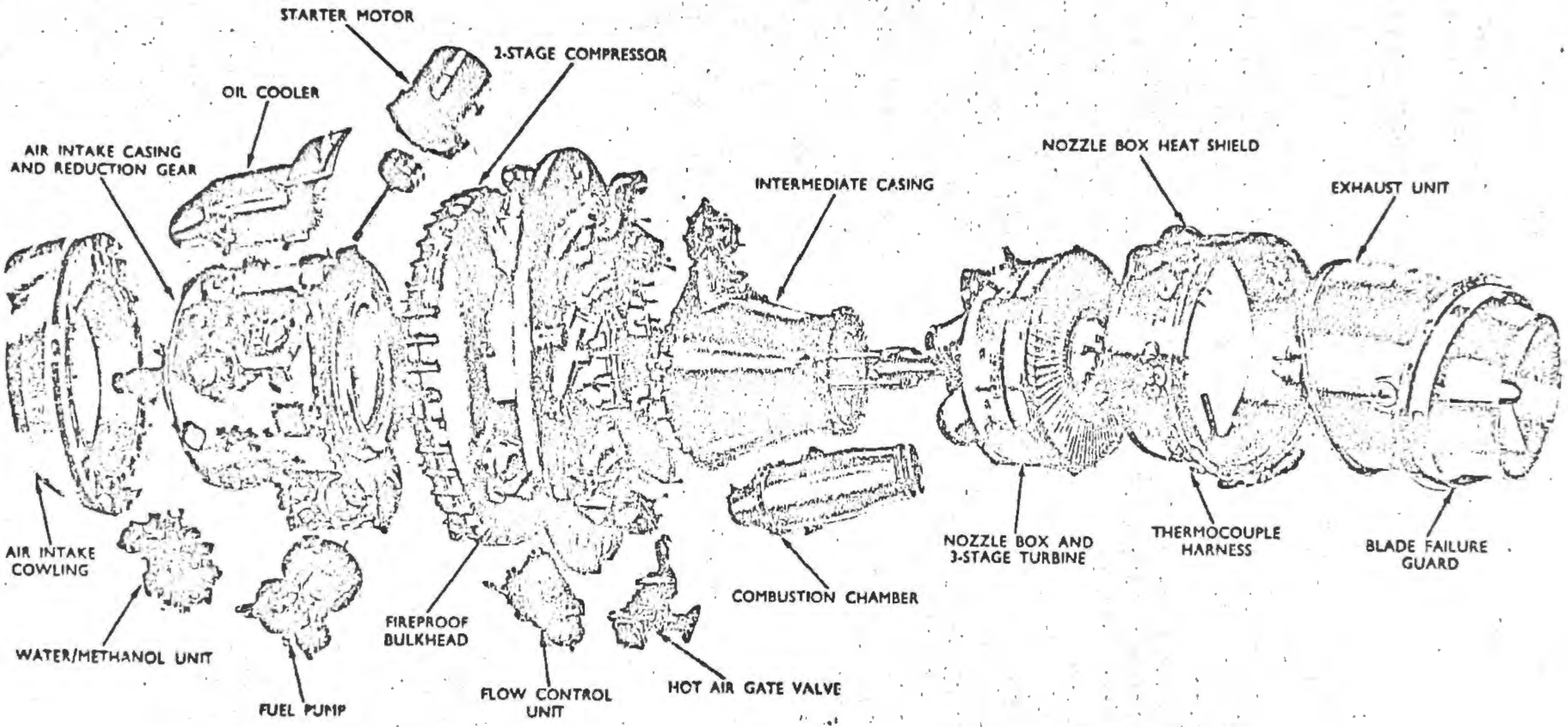
4.1.1 Major Components

The engine consists mainly of the following units.

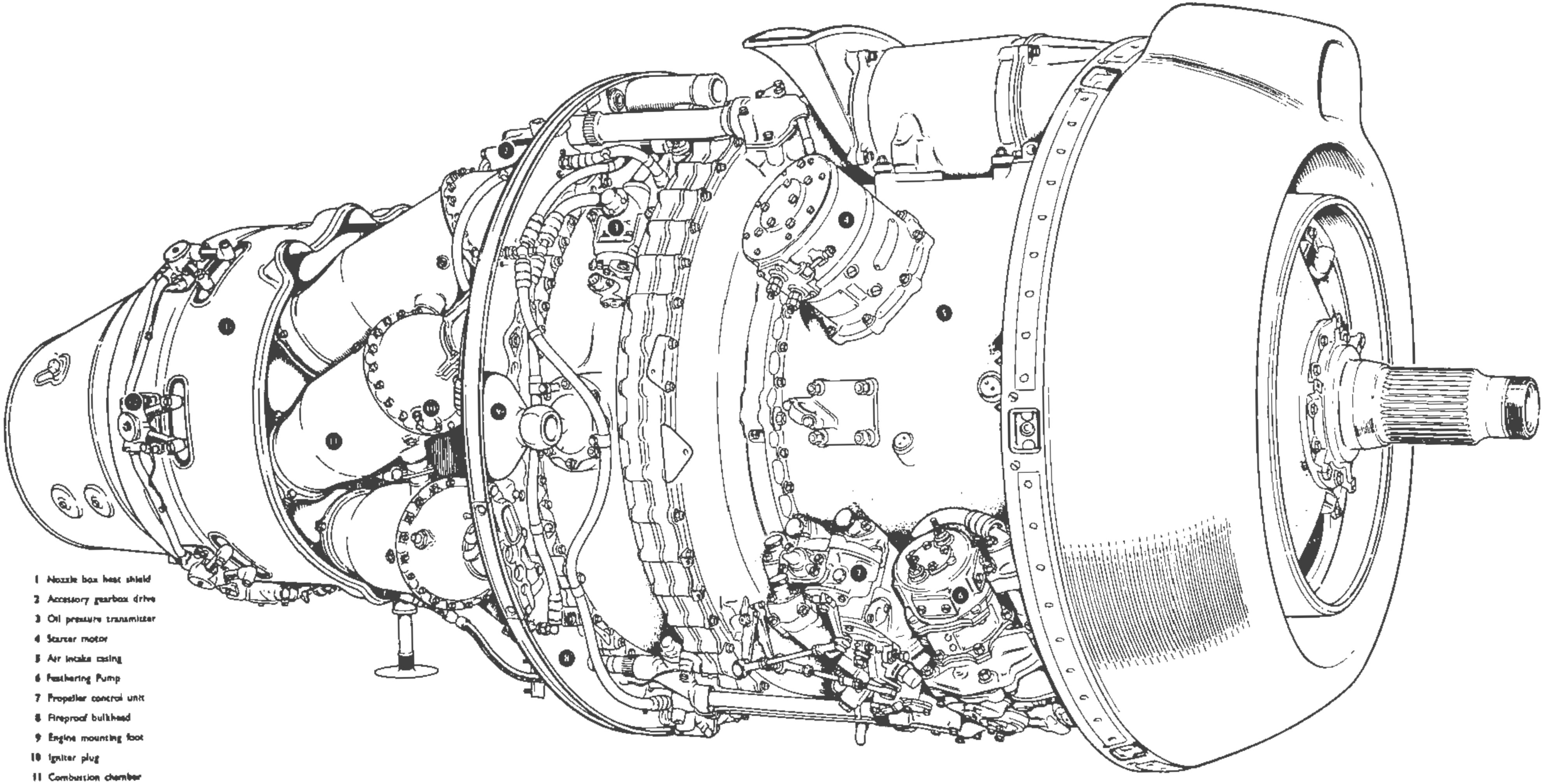
Air Intake Casing
Two-stage Centrifugal Compressor and Main Casing
Compressor Outlet Casing
Combustion Chamber
Turbine Assembly surrounded with Nozzle Box
Exhaust Unit

4.1.2 Rotating Assembly

The compressor rotor is rotated directly by the turnbine through the turbine shaft and the coupling shaft. Therefore, if there takes place such a trouble as a broken shaft, the turbine will be subject to overspeed. To prevent such a trouble, the propellers are designed to be rotated each by a propeller drive shaft, other than the compressor shaft, through the reduction gear. This propeller drive shaft is called "the inner drive shaft" which is located inside the hollow compressor drive shaft and connected to the high-speed pinion shaft of the reduction gear. (See Fig. 4-5-1)

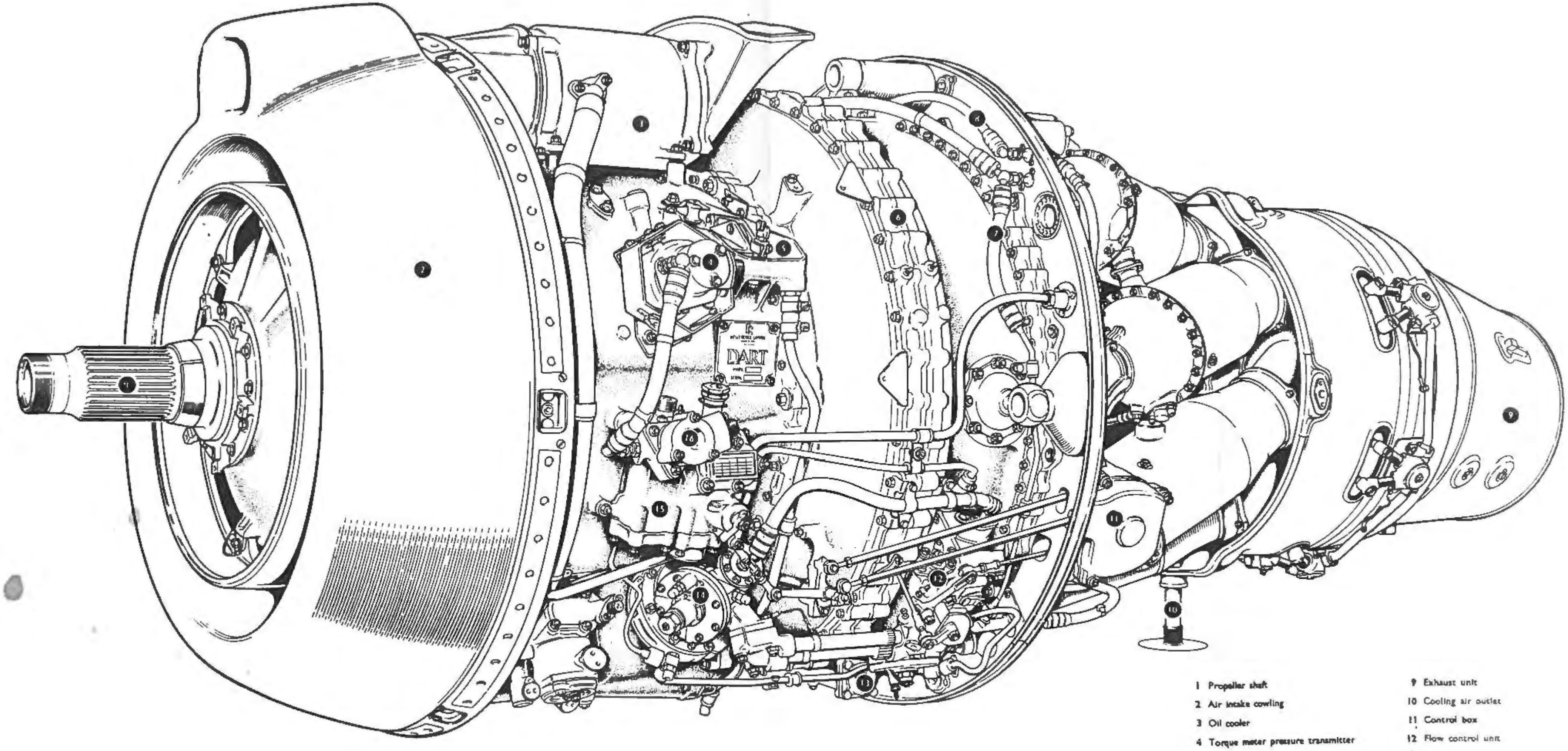


ENGINE MAIN UNITS Fig. 4-1



1 Nozzle box heat shield
2 Accessory gearbox drive
3 Oil pressure transmitter
4 Starter motor
5 Air intake casing
6 Feathering Pump
7 Propeller control unit
8 Fireproof bulkhead
9 Engine mounting foot
10 Igniter plug
11 Combustion chamber
12 Thermocouple

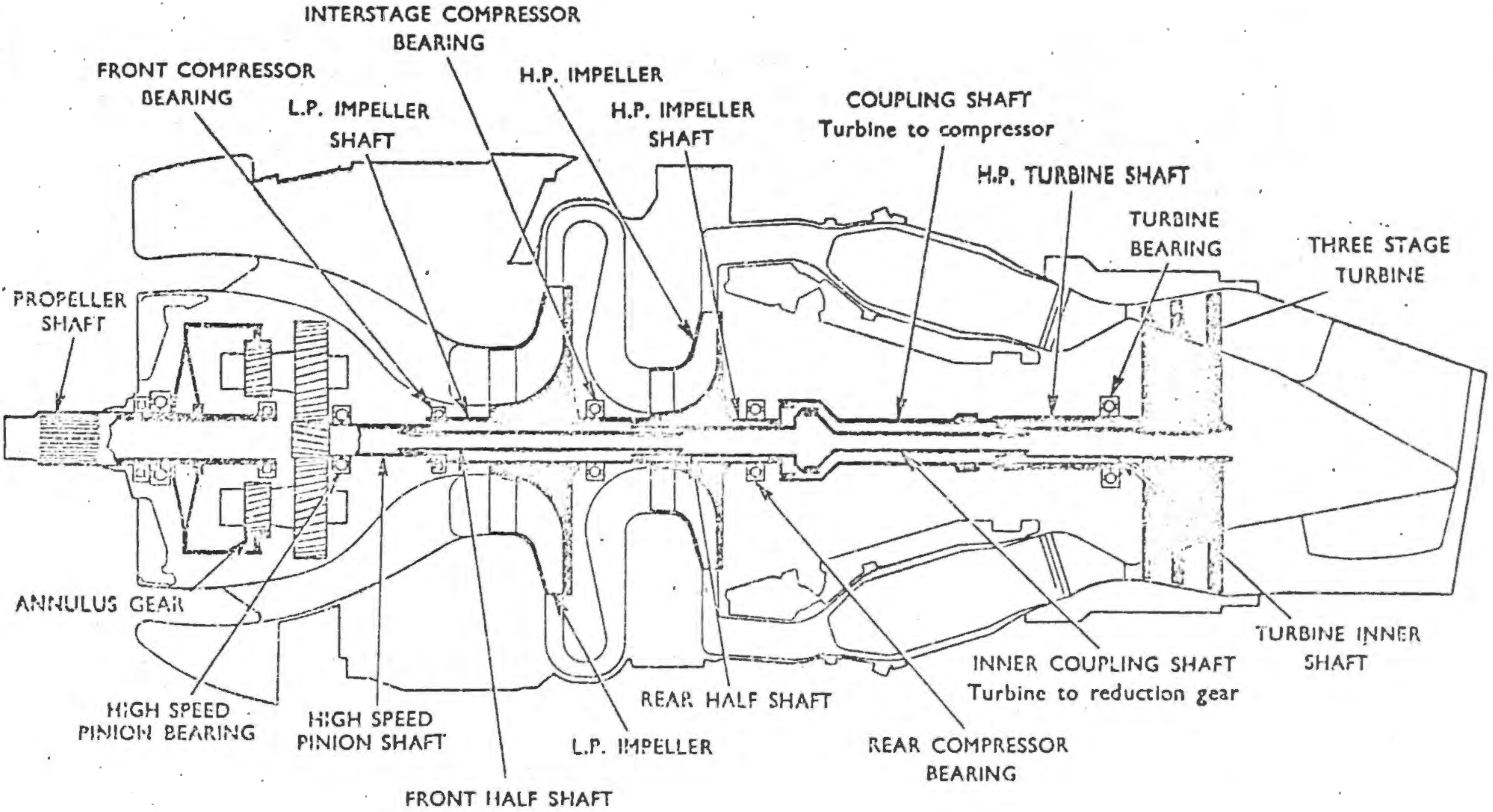
Dart engine - right-hand view
Fig. 4-2



1	Propeller shaft
2	Air intake cowling
3	Oil cooler
4	Torque meter pressure transmitter
5	Oil filler
6	Compressor casing
7	Fuel manifold - main
8	Fuel manifold - primary
9	Exhaust unit
10	Cooling air outlet
11	Control box
12	Flow control unit
13	Hot air valve
14	Fuel pump
15	Water/methanol unit
16	Low torque switch

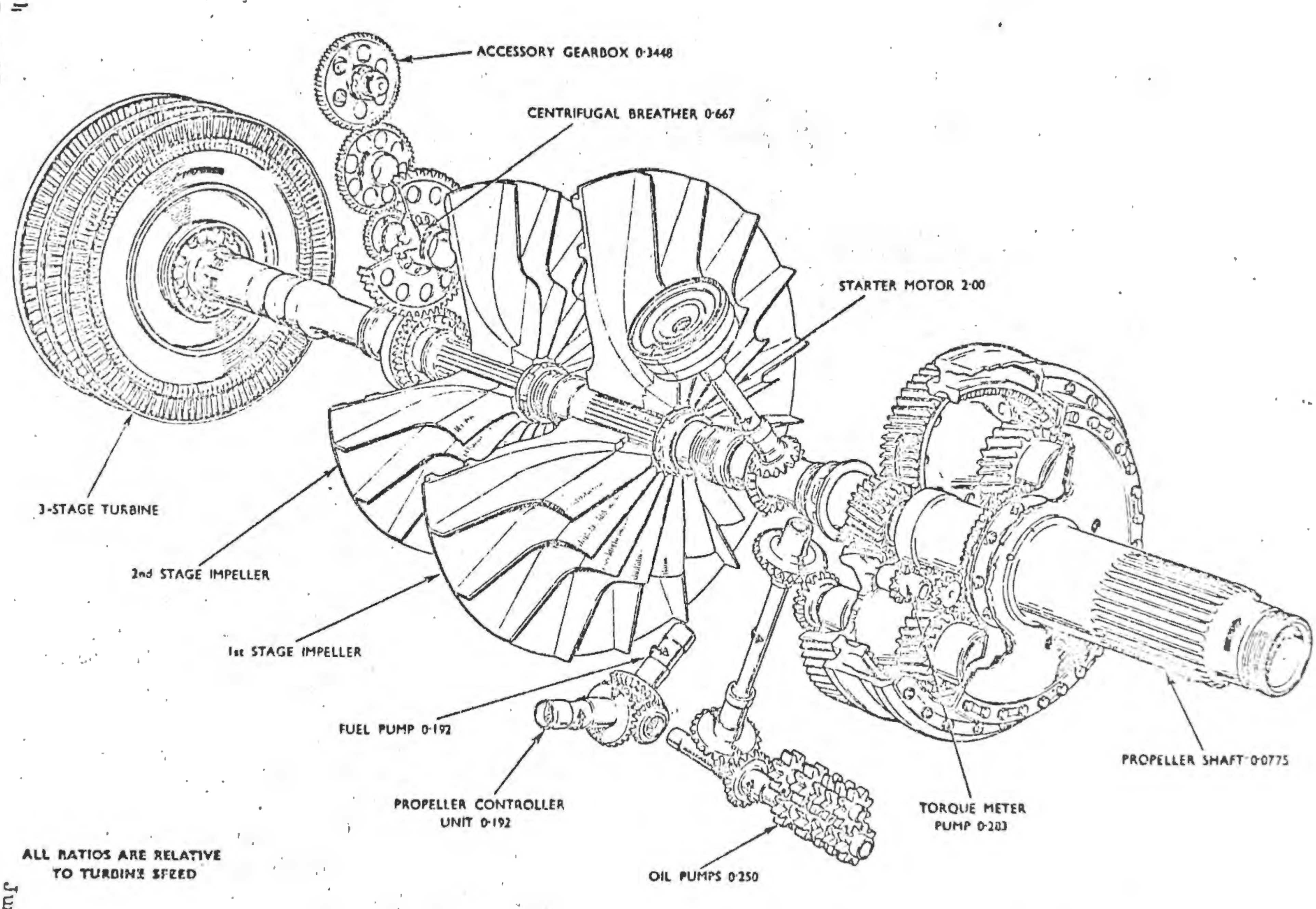
Dart engine - left-hand view

Fig. 4-3



ROTATING ASSEMBLY

Fig. 4-5-1



ALL RATIOS ARE RELATIVE TO TURBINE SPEED

Gear train diagram
Fig. 4-5-2

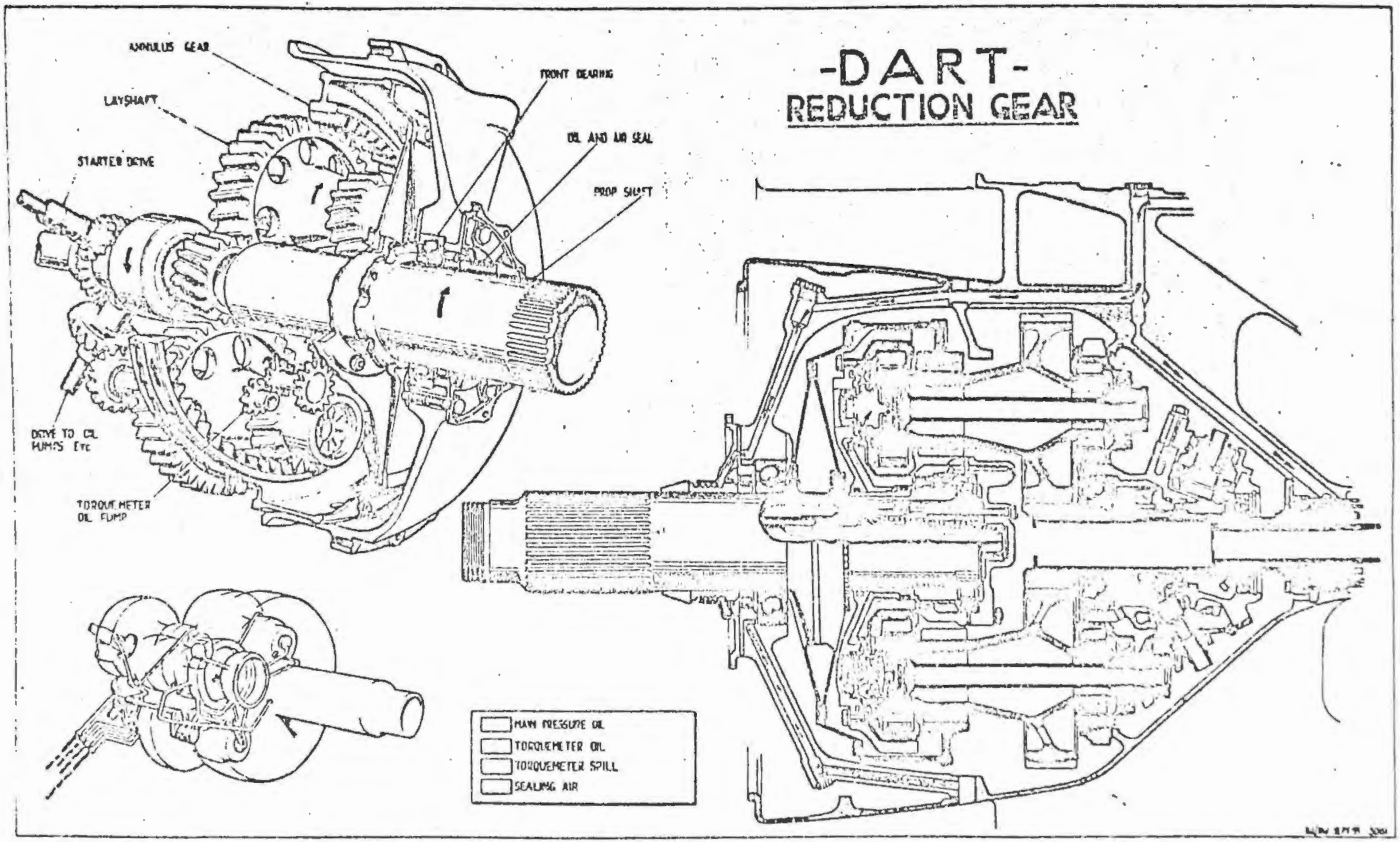

-DART-
REDUCTION GEAR
ANNULUS GEAR
LAYSHAFT
STARTER DRIVE
FRONT BEARING
OIL AND AIR SEAL
PROP SHAFT
DRIVE TO OIL PUMPS ETC
TORQUEMETER OIL PUMP
MAIN PRESSURE OIL
TORQUEMETER OIL
TORQUEMETER SPILL
SEALING AIR

Fig. 4-6

4.1.7 Turbines

The heated air inside the combustion chambers flows into turbines in the nozzle boxes. The turbines are arranged in three stages, where most of the heated gas energy is absorbed, being converted into a torque for driving the compressors, propellers, and accessories. The turbine gas temperature (T.G.T.), which is important for engine control, is measured by means of the thermocouple located on the 2nd-stage nozzle guide vane.

4.1.8 Exhaust System

The exhaust system consists of engine exhaust unit, jet pipe assembly, and jet pipe shroud. The exhaust unit is fitted on the engine nozzle box and serves to supply the exhaust gas smoothly to the jet pipe so that the back pressure being applied to the turbines may be reduced.

4.1.9 Principle of Engine Control

The operation of Dart propeller turbines is performed by the following sequence of events.

(1) Intake and compression of the air.

(2) Addition of the fuel to the compressed air and combustion of the air-fuel mixture to increase the gross calorific value of the air flow.

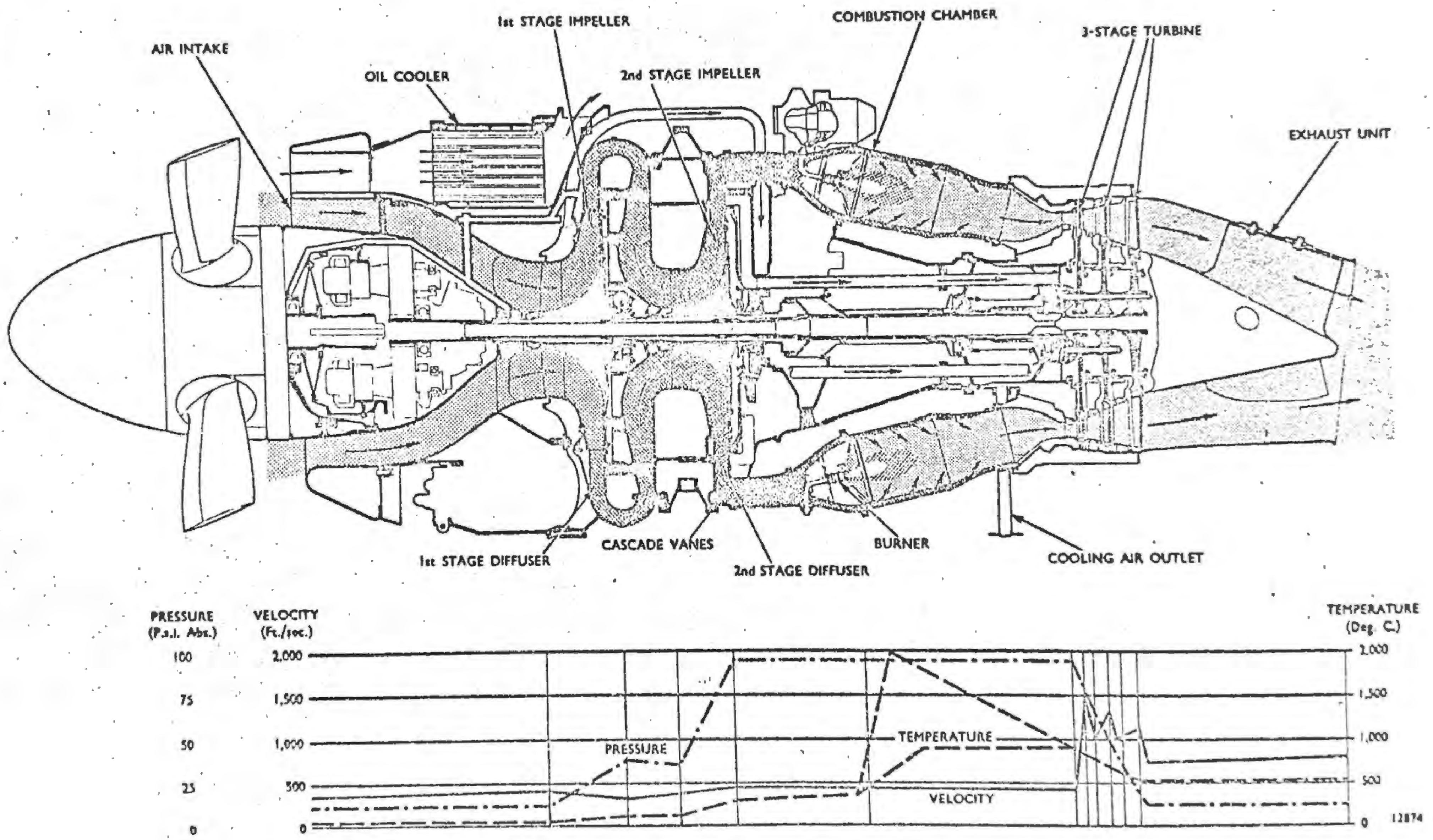
(3) Ejecting the expanded gas through the turbines to produce a power to turn the shaft for the drive of compressors and propellers.

(4) Utilization of energy still remaining in the exhaust gas as a small amount of jet thrust.

Generally, most of turbine power is used to drive the compressors. A small amount of power is used both for driving accessories and for internal friction. And residual power (about one third at maximum of the total power produced by the turbines) is used for the drive of the propellers.
The jet thrust, in terms of horse power, plus the shaft horse power, is called T.E.H.P. (Total Equivalent Horse Power). Power to be utilized for accessory drive is subtracted from T.E.H.P.
Power produced by the turbines depends on two elements: one is the air mass flow and the other is the temperature drop inside the turbines.

Air Mass Flow

The larger the air mass flow into the engine is, the greater the power increase. The air mass flow varies as the engine speed and the air density vary. The air density is affected by altitude, atmospheric temperature and airspeed. The permissible range of the air-fuel mixing ratio of Dart engine during cruise and at high outputs is 55:1 to 70:1. Higher ratios will become necessary for lower speed operation.



Gas flow diagram (15,000 r.p.m. I.S.A. sea level static)

Fig. 4-7

the minimum propeller governed speed (minimum constant speed) of 11,000 rpm. Open the throttles further to increase the fuel flow, and the T.G.T. rises while the speed remains steady. This is because the propeller pitch angle is varied by P.C.U. operation. This state continues until the throttles are opened wider to further increase the fuel flow and the engine speed. From this point on, the engines enter the flight operating range. Therefore, the air flow, fuel flow, and T.G.T. increase in proportion to the opening of throttle lever, finally reaching the maximum power condition. (Figs 4-10, -11) This appears as a special "step" on the Dart Engine Performance Curve (Fig. 4-10) at the speeds where the propellers are controllable. If the fuel is added to the engines running at a fixed speed, the air mass flow shows a slight decrease due to a slight decrease in necessary power for the compressors. (Fig. 4-8)

4.1.11 Effect of Outside Air Temperature

As previously stated, if the outside air temperature drops below I.S.A. (International Standard Atmosphere) temperature, the engine efficiency rises and the engine power tends to increase. However, since the fuel flow is restricted to a fixed limit, i.e., to a prescribed quantity of fuel in a static condition on the I.S.A. sea level, the T.G.T. can not be held at the maximum even when the outside air temperature drops and the air density, namely the air mass flow, increases. Accordingly the engine power is maintained at about the same value until the outside air temperature drops lower. (Fig. 4-13)

T.G.T. correction must be performed for power check when the T.G.T. drop follows the fall of the outside air temperature. (Fig. 4-15)

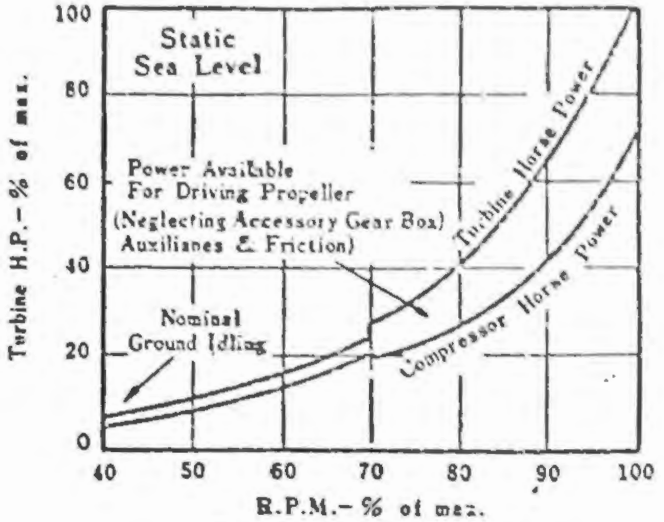
If the outside air temperature rises over I.S.A., the air density, i.e., the air mass flow decreases; at a fixed fuel flow, the T.G.T. rises. Therefore, the fuel flow must be decreased if the outside air temperature has exceeded I.S.A. so that the T.G.T will not exceed the permissible maximum temperature. Decreasing the fuel flow can be performed irrespective of the engine speeds, that is, without moving the throttle lever, but by operating the fuel datum control switch located in the cockpit. The fuel trim position indicator is provided to indicate its ratio.

Where the fuel datum has been set to "FULL INCREASE" (100%) by the indicator, no fuel flow decrease occurs. However, if the fuel datum is set to a slightly lower selected position, the fuel flow decreases in proportion to the aperture of the throttles throughout the throttle lever stroke of setting. This is called the fuel trim.

If the fuel datum is set to "FULL DECREASE" (0%), the fuel flow decreases about 25% of that in the case that the fuel datum has been set to "FULL INCREASE." (Fig. 4-14)

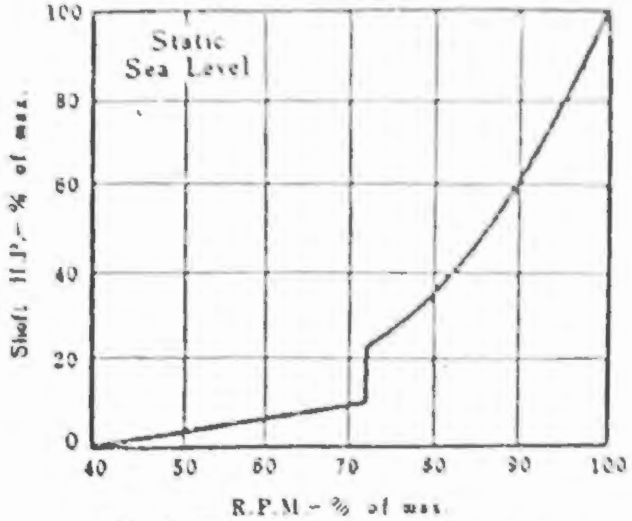
The selection of the fuel datum to any value obtained from the fuel datum position graph or table in accordance with the atmospheric temperature, automatically maintains the T.G.T. within the permissible range even if the throttle lever is moved to TAKE-OFF position. (Fig. 4-16)

When the I.S.A. is exceeded, the air mass flow decreases as mentioned above and the power produced by the turbine also decreases. It is the characteristic of the compressor driven by the turbine that the rise of the outside air temperature causes the compressor to less increase the air pressure. Besides, during hot weather, and at the fixed T.G.T., the gas temperature after passing through the turbines drops less and accordingly the engine power decreases further. Needless to say, power required by the compressors



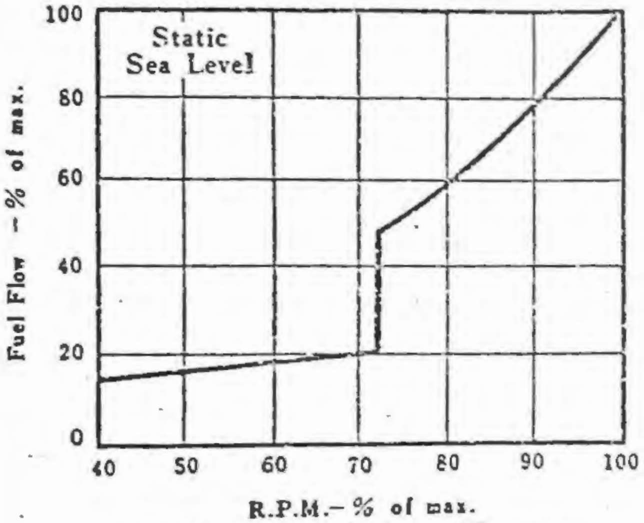
Turbine Power Output

Fig 4 – 8



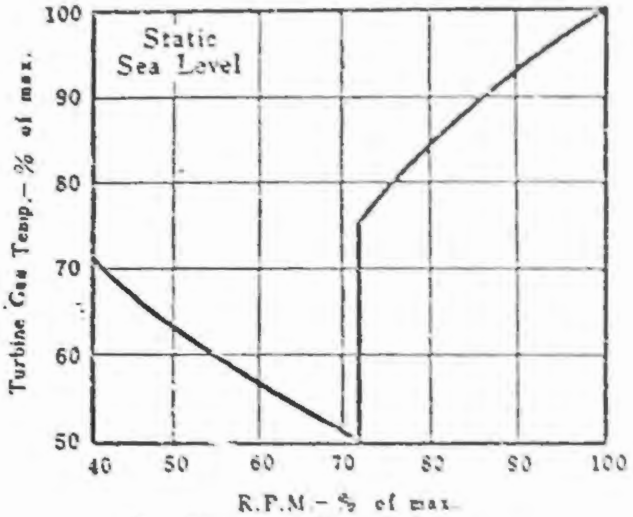
Shaft H.P. Variation with r.p.m.

Fig 4 – 9



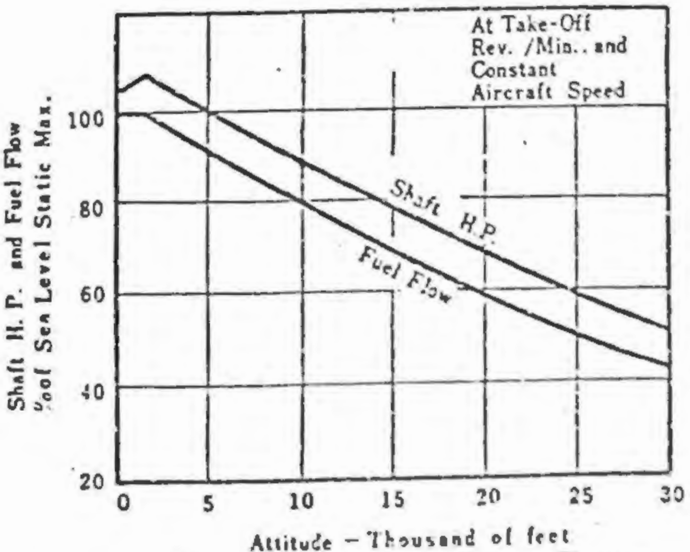
Fuel Flow Variation with r.p.m.

Fig 4 – 10



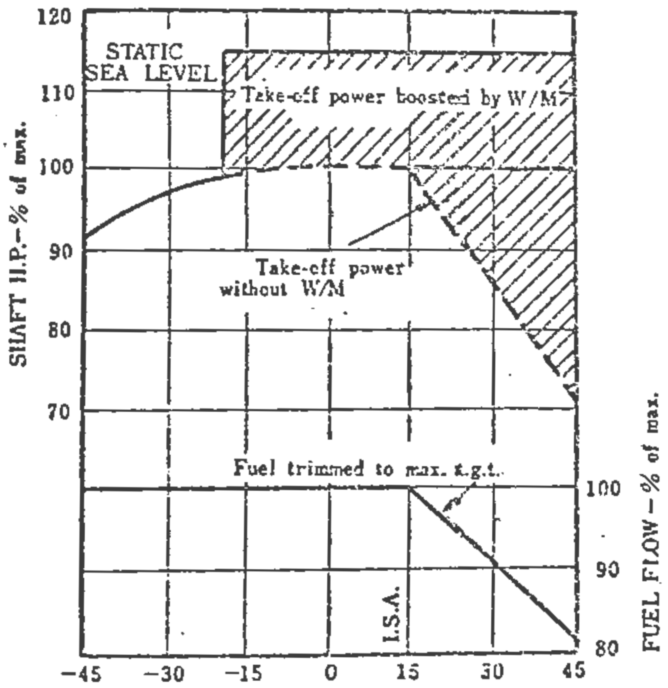
Turbine Gas Temperature
variation with r.p.m.

Fig 4 – 11



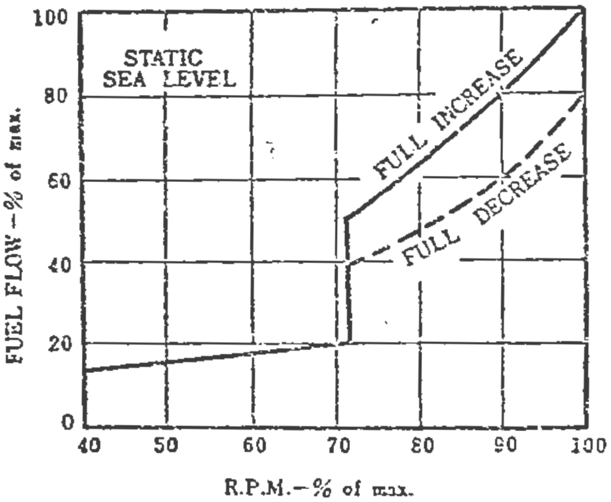
Effect of Altitude on Engine Power

Fig 4 – 12



Power and fuel flow variation with atmospheric temperature

Fig 4 – 13



Fuel flow variation with r.p.m.

Fig 4 – 14

Compression ratio: 6-1/4 : 1

Dimentions:

Diameter ...... Approx. 38 in. max.
Length .... 99-1/2 in.
Weight (dry) .. 1,377 lbs. max.

Reduction ratio: 0.0775

4.3.2 Major Components

(1) Air Intake Cowling

(2) Air Intake Casing
    Reduction Gear
    Oil Tank
    Bevel Gear Assy

(3) Compressor Casing
    Rotating Guide Vane
    Compressor
    Diffuser Vane

(4) Combustion Chamber
    Burner

(5) Intermediate Casing
    Bearing Housing

(6) Nozzle Box
    Nozzle Guide Vane
    Turbine Assy
    Heat Shield

(7) Exhaust Unit

(8) Oil Cooler and Oil System

(9) Water/Methanol Unit

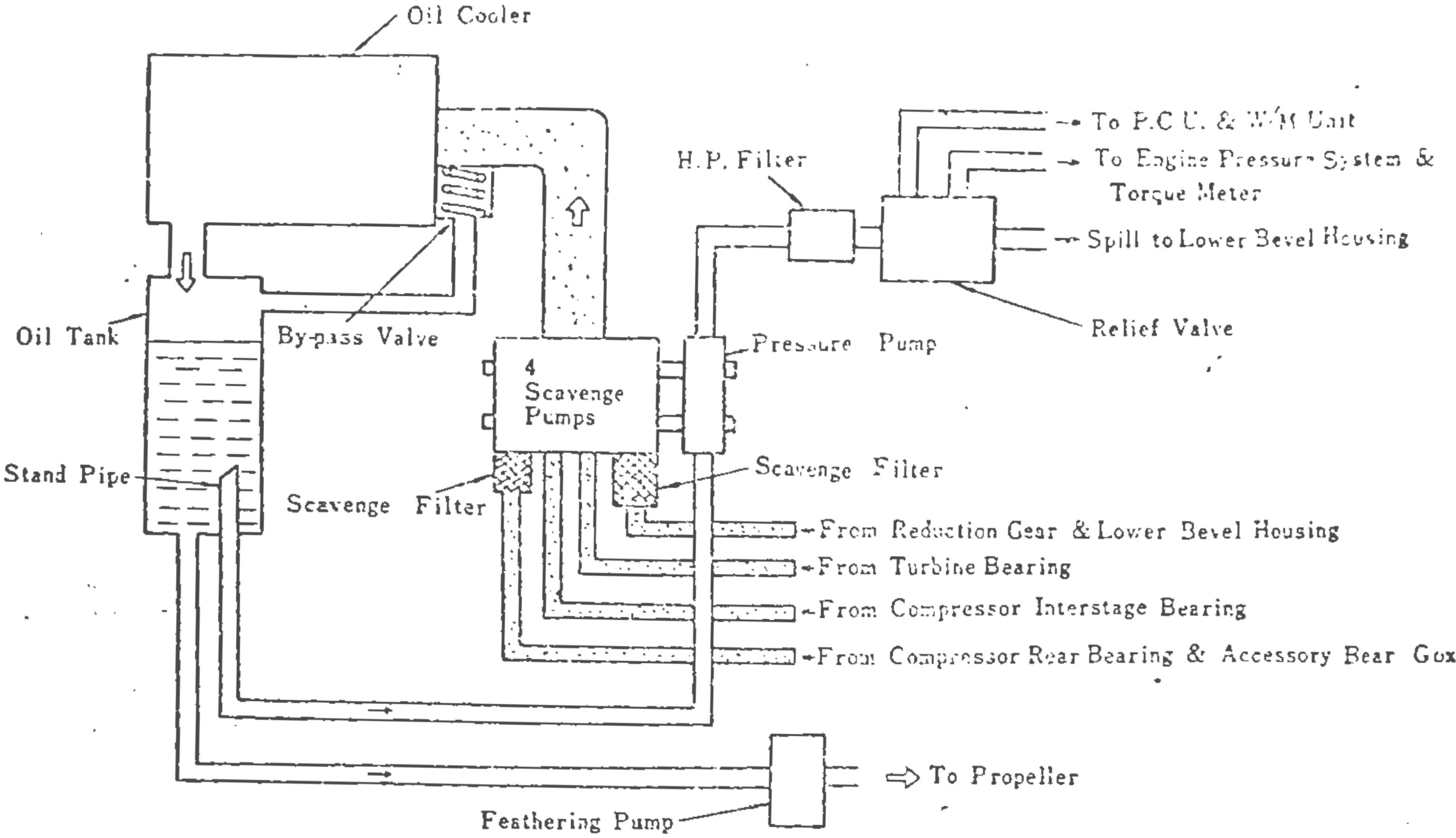
(10) F.C.U. and Fuel Pump

(11) P.C.U. and Feather Pump

(12) Starter Motor and Ignition System

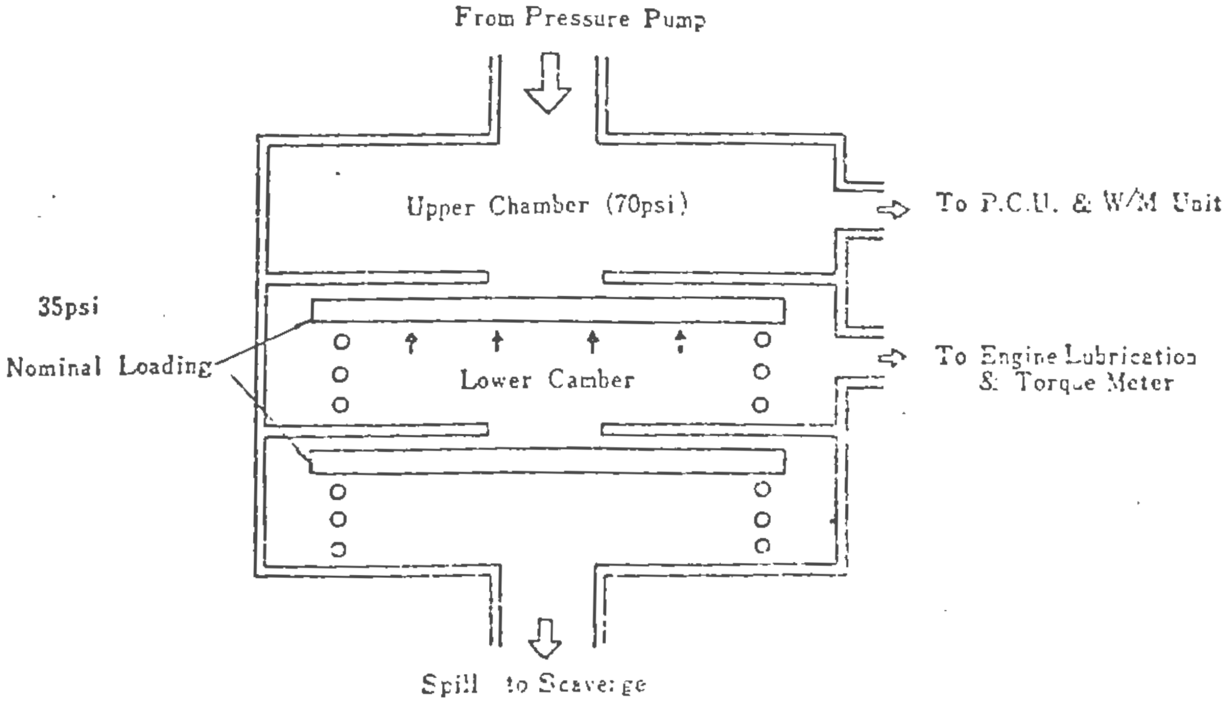
(13) Accessory Gear Box

(14) Fire Detector and Fire Extinguisher


Oil Cooler
To P.C.U. & W/M Unit
H.P. Filter
To Engine Pressure System & Torque Meter
Spill to Lower Bevel Housing
Oil Tank
By-pass Valve
Relief Valve
Pressure Pump
4 Scavenge Pumps
Stand Pipe
Scavenge Filter
Scavenge Filter
From Reduction Gear & Lower Bevel Housing
From Turbine Bearing
From Compressor Interstage Bearing
From Compressor Rear Bearing & Accessory Bear Gox
To Propeller
Feathering Pump

Oil System

Fig 4 – 20



Oil Press. Relief Valve
Fig 4 – 21

4.1.3 Reduction Gear

The propeller drive rpm of the turbine shaft must be reduced to a prescribed value by means of the reduction gear of a high reduction ratio. If not, it is high great and inadequate for propeller rotation.
This reduction is done by means of the high-speed pinion and the three layshaft assemblies engaged with the pinion, and the annulus gear having gears inside and driven by the layshaft. The annulus gear is bolted to the propeller shaft. In this system are employed helical teeth.
The forward thrust produced by layshaft rotation is balanced by the oil pressure applied to one side of the piston located to the fore of the layshaft, whereby the pressure is measured as the index of the engine power. This pressure is designated as the torquemeter pressure.
The lower layshaft serves to drive the bevel gear assembly installed in the lower part of the air intake casing., Oil pump, propeller control unit (P.C.U.), and fuel pump are driven by the output drive shaft extending from the bevel gear assy. The reduction gear functions to reduce the drive power at the ratio of 1 to 0.0775.

4.1.4 Air Intake

In the air intake casing of magnesium alloy casting are installed the reduction gear and the oil tank. On its front end is fitted the nose cowling on which the electrical de-icing element is attached. The rear end of the cowling has the flange fitted to the nacelle cowling.
On the left-hand side of the air intake casing, the oil filter, water/methanol unit, and fuel pump are installed. On the right-hand side are the propeller control unit, feathering pump and starter motor. The oil cooler is fitted on the top of the casing while the engine oil system accessory is on the lower side.

4.1.5 Compressors

The compressor assembly consists of magnesium alloy casting front compressor casing, two-stage compressor, intermediate casing, and compressor outlet casing. The two-stage compressor is housed in the main casing of aluminium alloy casting. In the main casing are fitted three engine mounts, the hot air gate valve on the lower side, and the fuel flow control unit (F.C.U.) on the left-hand lower part. The compressed air flows from the compressor outlet casing into the combustion chambers.
On the outlet casing are fitting the breather outlet, accessory drive adapter, and compressed air spill outlet. The engine fire wall also is attached to it.

4.1.6 Combustion System

The combustion system, consisting of seven combustion chambers, is attached on the intermediate casing and connected to the turbine nozzle box.
Each combustion chamber is fitted with the flame tube and burner. The burner is provided to inject the fuel into the tube to prepare and burn the air-fuel mixture.
The third and seventh combustion chambers only are provided with high energy ignitor plugs for lighting at the time of engine start. Ignited flame is propagated to other combustion chambers through interconnectors.

Temperature Drop

Gas temperature difference between turbine inlet and outlet indicates the quantity of energy absorbed by the turbines. Accordingly if this difference is great, it means that a great amount of energy has been absorbed by the turbines. From this, it is understood that a recommended way to improve the engine efficiency is to raise the gas temperature at the turbine inlet as high as practicable. However, it is impossible to increase the temperature unrestrictedly due to the strength limitation of materials of engines. From this reason, it is recommended to operate the turbine engines at the highest possible turbine entry temperature as long as their high reliability and long life are secured.
For this purpose, the limitations of operating temperatures for take-off, maximum continuous, and cruise operations are specified for engines.
High pressure and large temperature drop can be obtained at the same turbine entry temperature at low outside air temperature than at high outside air temperature.
Consequently the maximum engine power can be obtained at low temperatures when the turbine entry temperature is kept constant by the fuel.
Under the same atmospheric conditions, the air mass flow entering the engine is determined by the engine speeds. The engine speed can be selected within the range between the take-off speed of 15,000 rpm and the minimum constant speed of 11,000 rpm by means of the propeller control unit (P.C.U.) and the variable pitch propeller.
The fuel flow, which is controlled by the throttle valve, is supplied into the engines by the quantity corresponding to the air mass flow so that the maximum turbine entry temperature will not be exceeded for purpose of maintaining the proper operating state of the engines. To this end, the propeller control unit and the throttle valve are interconnected each other by means of a lever. Namely, the pilot can control the engine by using one lever.
For engine power indication, the T.G.T. indicator with a centigrade scale and the engine speed indicator are employed. Beside these, a torque pressure gauge graduated in psi is provided for the indication of propeller shaft horse power.
Actually, since it is hard to measure the turbine entry temperature, the thermocouple is attached on the intermediate nozzle guide vane and the temperature measured there, T.G.T. is regarded to be the most approximate turbine entry temperature. This plays the most important role in engine operation and adjustment.

4.1.10 Engine Power Control

One engine start, or at idling on the ground, most of the turbine power is used for driving the compressors. (Fig. 4-14) The propellers, therefore, are so designed as to be adjustable to the angle 0° designated the ground fine pitch stop. The propellers are also provided with the pitch lock so that their blade angle will not be decreased below the flight fine pitch stop at 14° because the windmilling drag tends to grow very great in case of an engine trouble in flight.
As the throttle lever is gradually moved from the ground idling position toward OPEN, the engine speed and fuel flow increase but the propellers are held at the aforementioned ground fine pitch stop until their speed reaches

AMBIENT TEMPERATURE (deg.C.)	-1,000	-500	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000	AMBIENT TEMPERATURE (deg.C.)
+21	0																		+21
+19	3																		+19
+17	9	0																	+17
+15	16	6	0																+15
+13	22	12	5	0															+13
+11	28	18	12	3															+11
+ 9	34	24	18	10	0														+ 9
+ 7	40	30	24	16	7	0													+ 7
+ 5	46	36	30	22	13	4	0												+ 5
+ 3	52	43	36	28	20	10	2												+ 3
+ 1	58	49	42	34	26	17	8	0											+ 1
- 1	64	55	48	40	32	23	14	7	0										- 1
- 3	70	60	54	46	38	29	21	13	6	0									- 3
- 5	76	66	60	52	44	35	27	20	12	5	0								- 5
- 7	81	72	66	58	49	41	33	26	19	11	5	0							- 7
- 9	87	78	72	64	55	47	39	32	25	18	11	4	0						- 9
-11	92	83	79	69	61	53	45	38	31	24	17	10	4	0					-11
-13	98	89	83	74	66	58	51	44	37	30	23	16	10	3	0				-13
-15	104	94	88	80	72	64	56	50	43	36	29	23	16	9	3	0			-15
-17	109	100	94	86	78	70	62	55	48	41	35	29	23	16	10	3	0		-17
-19	114	105	99	91	83	75	68	61	54	47	41	34	29	22	16	9	3	0	-19
-21	120	111	104	96	88	81	73	66	59	52	46	40	34	28	22	16	9	3	-21
-23	126	116	110	102	94	86	79	72	64	58	52	46	40	34	28	22	16	10	-23
-25			115	107	99	92	84	77	70	63	57	51	46	40	34	28	22	16	-25
-27					104	97	90	82	75	68	62	56	51	45	40	34	28	23	-27
-29							95	87	80	73	68	62	56	50	46	40	34	29	-29
-31								91	84	78	72	66	61	56	51	46	40	35	-31
-33										83	77	72	66	61	56	51	46	41	-33
-35												76	71	66	61	56	51	47	-35
-37															66	61	56	52	-37
-39																		57	-39

NO CORRECTION

Engine power checks should not be carried out in ambient conditions in excess of I.S.A. +35 deg. C.

PRESSURE ALTITUDE (ft.)

G1746

NOTE: Subtract the correction value obtained from this table from the appropriate T.G.T. limitation

T.G.T. corrections at 15,000 r.p.m. (tabular)

Fig. 4-15

AMBIENT TEMPERATURE (deg.C.)	-1,000	-500	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000	AMBIENT TEMPERATURE (deg.C.)
+51	52																		+51
+49	55	48	46																+49
+47	58	51	49	44															+47
+45	61	53	51	46	41														+45
+43	64	56	54	49	44	39													+43
+41	67	59	57	52	46	42	37												+41
+39	70	62	60	55	49	45	40	35											+39
+37	73	65	63	58	52	47	43	38	33										+37
+35	76	69	66	61	55	50	45	40	36	32									+35
+33	80	72	69	64	58	53	48	43	39	35	31								+33
+31	83	75	72	67	61	56	51	46	41	38	34	30							+31
+29	86	79	75	70	65	59	55	49	44	40	36	33	29						+29
+27	90	82	79	73	68	62	58	52	47	43	39	36	32	29					+27
+25	93	85	82	77	71	66	61	55	51	46	42	39	34	31	28				+25
+23	97	89	85	80	74	69	64	59	54	49	45	42	37	34	30	27			+23
+21	100	92	89	83	78	72	68	62	57	53	48	45	40	37	33	30	26		+21
+19		96	93	87	81	76	71	65	61	56	52	48	43	40	36	32	29	25	+19
+17		99	96	91	85	79	75	69	64	60	55	51	46	43	39	35	31	28	+17
+15		100	100	94	89	83	78	72	68	63	59	54	50	46	42	38	34	31	+15
+13				98	92	87	82	76	71	67	62	58	53	49	45	41	37	34	+13
+11				100	96	90	86	80	75	70	66	62	57	53	48	44	40	37	+11
+ 9					100	94	90	84	79	74	70	65	60	56	52	48	44	40	+ 9
+ 7						98	94	88	83	78	73	69	64	60	56	51	47	43	+ 7
+ 5						100	98	92	87	82	77	73	68	64	59	55	50	46	+ 5
+ 3							100	96	91	86	82	77	72	68	63	59	54	50	+ 3
+ 1								100	95	90	86	81	76	72	67	62	58	54	+ 1
- 1									99	94	90	85	80	76	71	66	62	58	- 1
- 3									100	99	94	89	84	80	75	70	66	62	- 3
- 5										100	99	93	89	84	79	74	70	66	- 5
- 7											100	98	93	89	84	78	74	70	- 7
- 9												100	98	93	88	83	79	74	- 9
-11													100	98	93	87	83	79	-11
-13														100	97	92	88	83	-13
-15															100	97	93	88	-15
-17																100	97	93	-17
-19																	100	98	-19
-21																		100	-21

Engine power checks should not be carried out in ambient conditions denoted by this area of the table

FULL INCREASE

PRESSURE ALTITUDE (ft.)

Fuel datum position (tabular)

Fig. 4-16

also decreases. But the decrease of the power is very little compared with that of the turbine power, resulting in a decrease in the propeller shaft horse power. (Fig. 4-13)
Besides, for satisfactory take-off, the prescribed power can be maintained by boosting up the normal dry power by water/methanol injection even when the outside air temperature has varied. The water/methanol fluid serves to cool the compressor entry air, increasing the air mass flow and simultaneously improving important combustion efficiency. (Fig. 4-13) Thanks to this, a constant take-off power can be obtained within the range from the outside air temperature of -20°C to I.S.A. +30°C.

4.1.12 Specific Fuel Consumption

When the T.G.T. is kept at the maximum degree in sea level static condition, i.e., under the take-off condition, the efficiency and specific fuel consumption become optimum. As engine speed is decreased in cruising, T.G.T. decreases correspondingly and specific fuel consumption increases slightly.

4.1.13 Effect of Altitude and Airspeed

As the aircraft climbs, the power required by the aircraft decreases. The engine power also decreases with the decreases of the air density. (Fig. 4-12). However, the drop of the outside air temperature caused by the rise of altitude improves efficiency as stated earlier, and the specific fuel consumption continues to be satisfactory up to the altitude where the propeller efficiency will begin to decrease.
An increase in speed results in an increased air intake pressure and also increased air mass flow. However, the intake temperature rises though slightly due to ram efficiency. Usually, the fuel flow increases or decreases depending on the change of this air mass flow so that T.G.T. is maintained at the prescribed degree. Also, the turbine power increases or decreases slightly by the proportion of ram efficiency, i.e., total intake pressure/ambient pressure. Accordingly the airspeed increases the engine power.
Static, sea level condition and at the international standard atmosphere, the fuel flow is the greatest; and accordingly even if the air mass flow is increased due to the increased airspeed, the fuel flow will not increase. Due to this, the T.G.T. will drop and engine power increase will be restricted.
As the aircraft climbs above the sea level, the air intake pressure and air mass flow gradually decrease.
But the maximum fuel flow is maintained until the ram air intake pressure decreases down below the pressure of 14.9 psi at I.S.A. when the aircraft is in static sea level condition, and the fuel control unit begins to decrease the fuel flow.
Up to this point, the fuel flow is kept constant against the decrease of the air flow; and accordingly the T.G.T. rises and the engine power increases.
As the aircraft goes much higher, the air intake pressure and mass flow further decrease and the fuel flow automatically decreases so that the T.G.T. limit will not be exceeded. And power decrease follows it.
(Fig. 4-12)

4.2 Engine Control

4.2.1 Cockpit Controls

The engine power is controlled from the cockpit by the engine speed control through P.C.U. and also by operating a single throttle lever mechanically connected to the fuel flow control unit.

Since the engines are operated at varied outside air temperatures, the fuel trimmer is used for the control of the fuel flow suited to the engine speed so that the T.G.T. may be kept invariably within the limit. This fuel trimmer is a 3-position fuel datum switch to operate the actuator built in the engine control linkage.

In the cockpit is also installed the high pressure fuel cock lever (H.P.C. lever), which has two functions: one is as a high-pressure fuel control cock in the fuel system and the other as a propeller feather selector.

Place the H.P.C. lever in OFF position, and the high-pressure fuel flow to the engines is cut off and the microswitch is simultaneously actuated to shut off the water/methanol supply. Set the H.P.C. lever in FEATHER, and the other microswitch is operated to prevent the other engine from being auto-feathered.

4.2.2 Ground Control

Open the throttles from the idling position, and the propeller pitch remains at 0° (ground fine pitch stop). With the increase of fuel flow, the engine speed increases till it reaches 11,000 rpm (minimum constant speed). Within a range above this point, the rpm remains at 11,000 rpm even when the throttles are opened wider, and the propeller pitch increases and the engine power increases. Open the throttles much wider, and the rpm and fuel flow increase up to the predetermined values respectively, the engine power and T.G.T. increasing proportionally.

Move the fuel trimmer toward "DECREASE," and the fuel flow decreases and the engine power also is lowered irrespective of the throttle position.

When the propellers are rotating at 11,000 rpm or less with their pitch at 0°, with the fuel trimmer set to "DECREASE," the speed decreases.

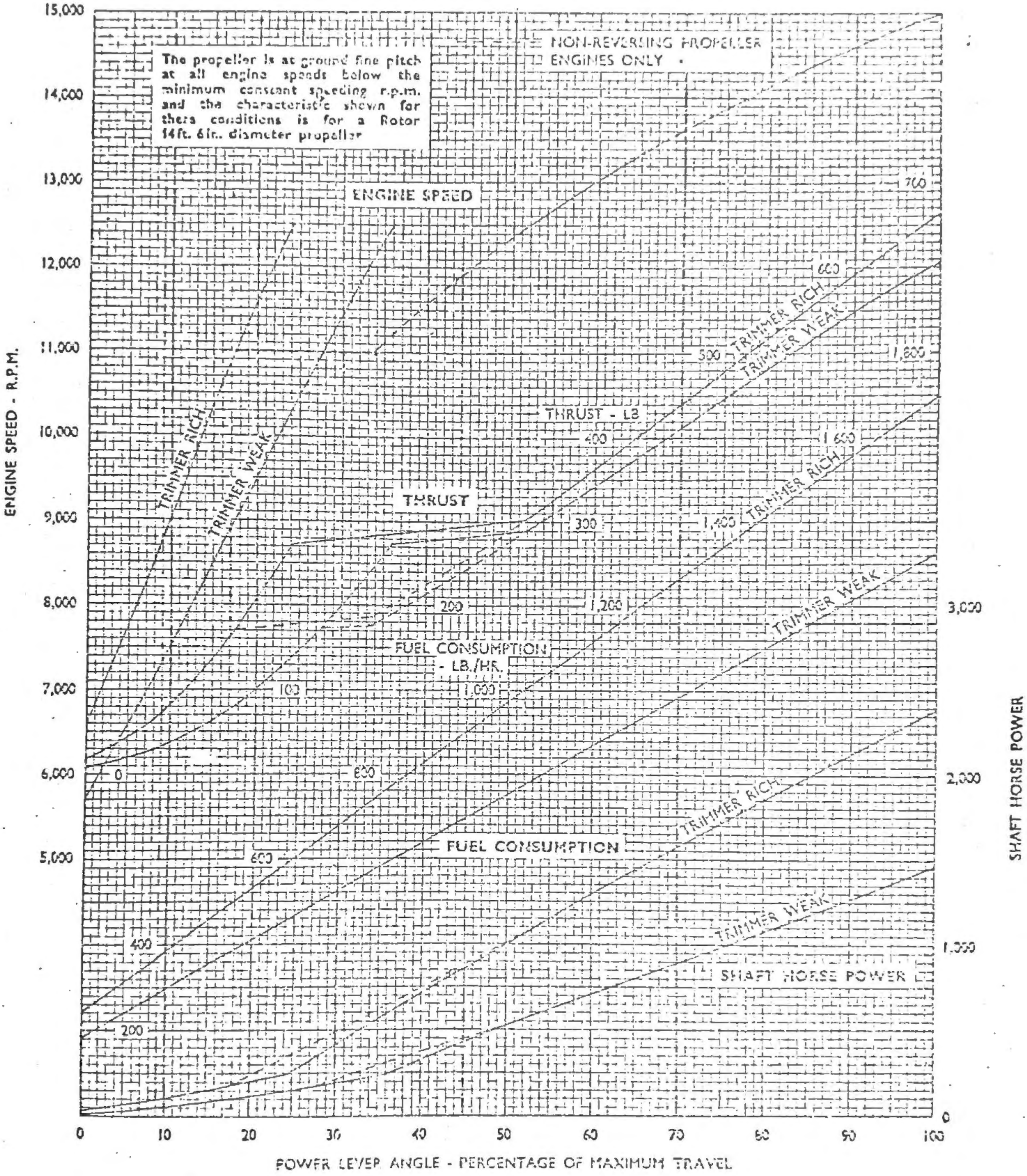
Set the trimmer to "INCREASE," and the speed increases. Accordingly when the throttles are opened with the fuel trimmer placed in "DECREASE" position, the throttle travel grows longer until the speed reaches 11,000 rpm; but on the contrary, it becomes shorter during the period when the speed of 11,000 rpm is maintained. (Fig. 4-17)

4.2.3 In-flight Control

In the initial stage of take-off, the engine control is done by the same procedure as in ground control. With an increase in speed, the propeller pitch increases and exceeds the flight fine pitch stop irrespective of the atmospheric conditions.

During climb and cruise, the engine speed can be set to any rate within the range of speeds fixed by the propeller control unit by means of the throttle lever. Also, at any rpm, the use of the fuel trimmer is possible for the control of both the T.G.T. and the fuel flow.

AVERAGE PERFORMANCE ENGINE
RELATIONSHIP BETWEEN STATIC SEA LEVEL PERFORMANCE AND POWER LEVER ANGLE AT I.S.A.


The propeller is at ground fine pitch at all engine speeds below the minimum constant speeding r.p.m. and the characteristic shown for these conditions is for a Rotor 14ft. 6in. diameter propeller

NON-REVERSING PROPELLER ENGINES ONLY

Fig. 4-17

In normal descent, the propeller pitch is invariably over the flight fine pitch stop; and the propeller control unit always maintains the minimum constant speed of 11,000 rpm. While the speed lever of the propeller control unit is within the range of the minimum constant speed, power adjustment can be done by means of the throttle lever. Its fine adjustment also can be performed by using the fuel trimmer.
At an idling speed during approach and landing, the throttles are closed, the fuel flow is decreased for idling, and the propeller pitch is held at the flight fine pitch stop of 14° and will not be decreased further. Accordingly the engine speed may in some cases decrease below 11,000 rpm because the propellers may become a windmilling drag depending upon the air speed.

4.2.4 Water/Methanol

The duty of the water/methanol system is to increase the engine horsepower at the time of take-off below 10,000 feet and at the outside air temperatures between -20°C (the freezing temperature of water/methanol) and I.S.A. +30°C. The pilot can operate the water/methanol system in the cockpit by pushing the water-methanol booster pump switch "ON" and also the water/methanol master switch (a switch for operating the cock installed in the line routed from the tank up to the engine) "ON." Whether the system is properly operating or not can readily be recognized by the indicator light. When the throttle lever is moved to 14,800 rpm or over, the water/methanol solution flows into engines; and with the lever moved below 14,800 rpm, the supply of the water/methanol fluid is shut off. The water/methanol system automatically stops when the H.P.C. lever is placed in "FUEL OFF" or when the auto-feathering circuit is energized.

4.3 Major Components

4.3.1 Engine Data

Power:

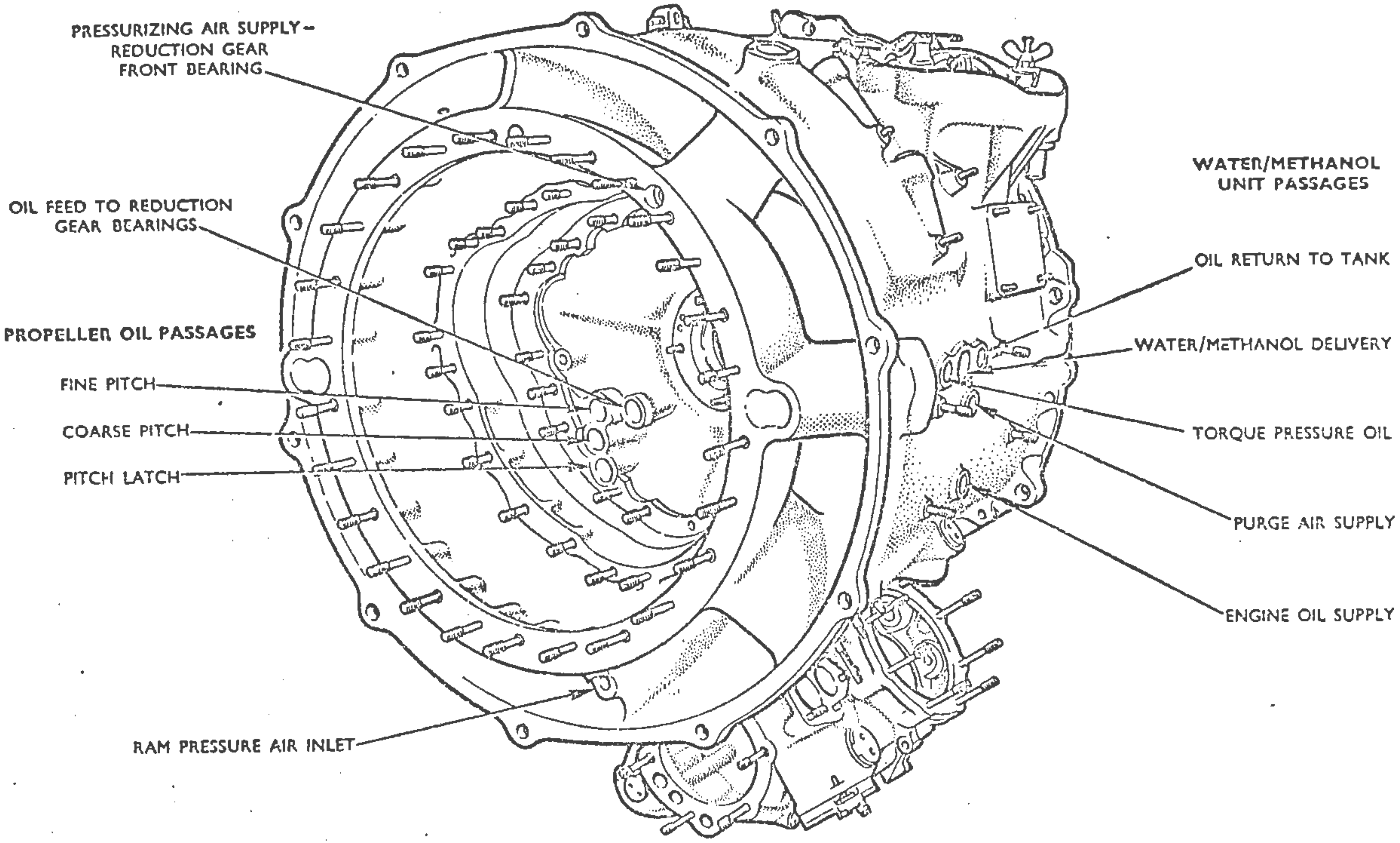
(In Sea Level Static Condition at I.S.A.)

	R.P.M.	S.H.P.	Thrust		T.E.HP	Fuel Consumption lbs/hr. SHP
			lb.	kg		
Take-off (W/M injection)	15,000	2,775	740	(336)	3,060	-------
Take-off (Without W/M)	15,000	2,400	660	(299)	2,655	0.708
Maximum continuous	15,000	2,400	660	(299)	2,655	0.708
Maximum cruise	14,200	1,880	525	(238)	2,080	0.760

NOTE: As gear box horsepower, 70HP has been taken into account.

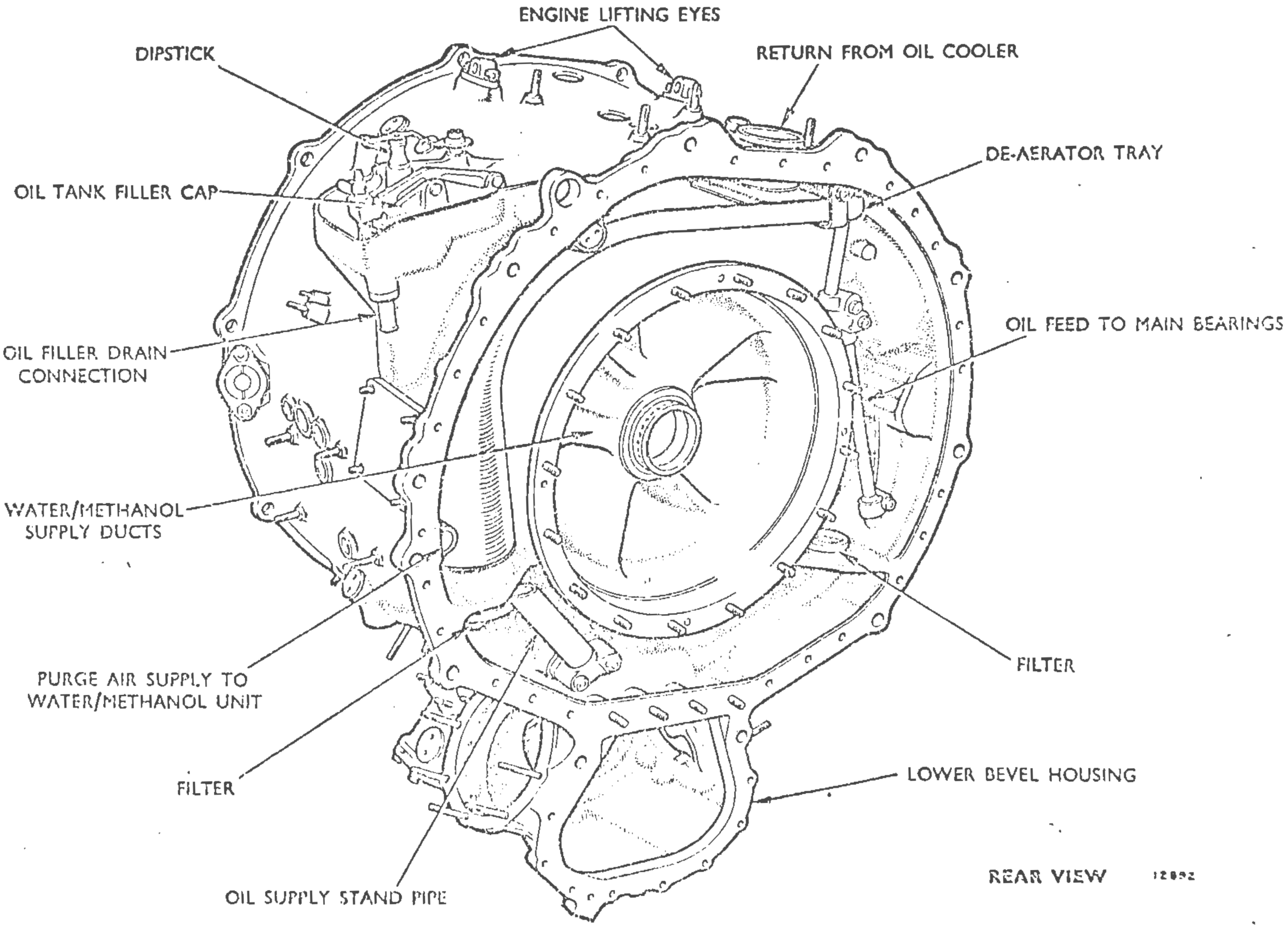
Direction of rotation:

Propeller .... Counterclockwise as viewed from the rear.
Engine .... Clockwise as viewed from the rear.



AIR INTAKE CASING FRONT VIEW

Fig. 4-10



AIR INTAKE CASING REAR VIEW

Fig. 4-19

4.4 Oil System

4.4.1 General

The engine oil system, which is totally enclosed in the engine, is provided to lubricate gears and bearings.
Furthermore, the lubricating oil is supplied from this system to propeller pitch control, torquemeter system and water/methanol control system.
The oil is supplied from a doughnut-shaped oil tank located in the air intake casing and forcibly circulated by means of one pressure pump and four scavenge pumps.

4.4.2 Data

Engine tank capacity:	30	Imp. pints
	36	US pints
	17.04	Liters
Usable oil:	10	Imp. pints
	12	US pints
	5.68	Liters
Feathering reserve:	11-1/2	Imp. pints
	13.8	US pints
	6.54	Liters
Total engine oil System capacity	47	Imp. pints
including propellers:	~~56.44~~	US pints 6[illegible]5
	26.7	Liters
System pressure:	35 psi	Engine lubrication Torquemeter
	70 psi	P.C.U. W/M unit

4.4.3 Oil Circulation

The lubrication oil is fed from the oil tank by means of the pressure pump. The oil tank, built in the circumferential space located to the aft of the air intake casing, has a capacity of approximately 30 pints. About 18-1/2 pints of the total capacity flows into the pressure pump past the standard pipe and the remaining about 11-1/2 pints of oil is reserved for feathering in an emergency. (Figs 4-20 and -22)
The oil pressurized by the pressure pump is regulated into two pressures by means of the oil pressure relief valve, which consists of two valves designed to relieve the pressure at 35 psi respectively. The total load of 70 psi oil is sent into the propeller control unit and the water/methanol unit while 35 psi of oil is fed into the engines for lubrication and the torquemeter system. (Fig. 4-21)
The oil after lubricating bearings and gear reduction housing is returned to the tank by means of the four scavenge pumps. Before returning to the oil tank, the oil is cooled when it passes through the oil cooler located in the upper part of the air intake casing. (Fig. 4-23)

The centrifugal breather system is provided for purpose of ejecting the air collected from the oil system. This system is designed to be driven by the 1st gear of the accessory gear box drive gears. The air flows from the oil tank, reduction gear and lower drive housing into the accessory drive housing past the hollow compressor shaft.
The oil used for lubricating the turbine bearings is air-sealed by the compressed air supplied from the compressor.
A spring-loaded by-pass valve is provided between the oil cooler inlet and outlet for the prevention of excessive increase of pressure at the time of engine start during cold weather when oil viscosity tends to be high. The valve is designed to be opened at 30 to 35 psi.

4.4.4 Checking the Oil System

The oil is a very important means to know the engine condition. On the ground, the condition of the engine interior can be known by oil color, foreign matters, and consumption while in the air the engine operating condition can be recognized by oil pressure and temperature.
At the oil tank outlet, the oil temperature bulb is fitted to measure the oil temperature. The oil pressure transmitter is fixed on the upper right-hand side of the compressor casing for the measurement of oil pressure.
At the bottom of the oil pressure transmitter is fitted the oil pressure warning light switch, which comes ON at the oil pressure of 5 to 6 psi, and the warning light in the cockpit comes on. (Fig. 4-25)

4.4.4.1 Oil Temperature Indicator

The oil temperature indicator is an instrument which indicates the oil temperature of both the right- and left-hand engines.
The indicator has a scale graduated from -50°C up to 150°C.
It also has the following marking:

Red radial line	-30°C
Yellow arc	-30°C to -15°C
Green arc	-15°C to +120°C
Red radial line	+120°C

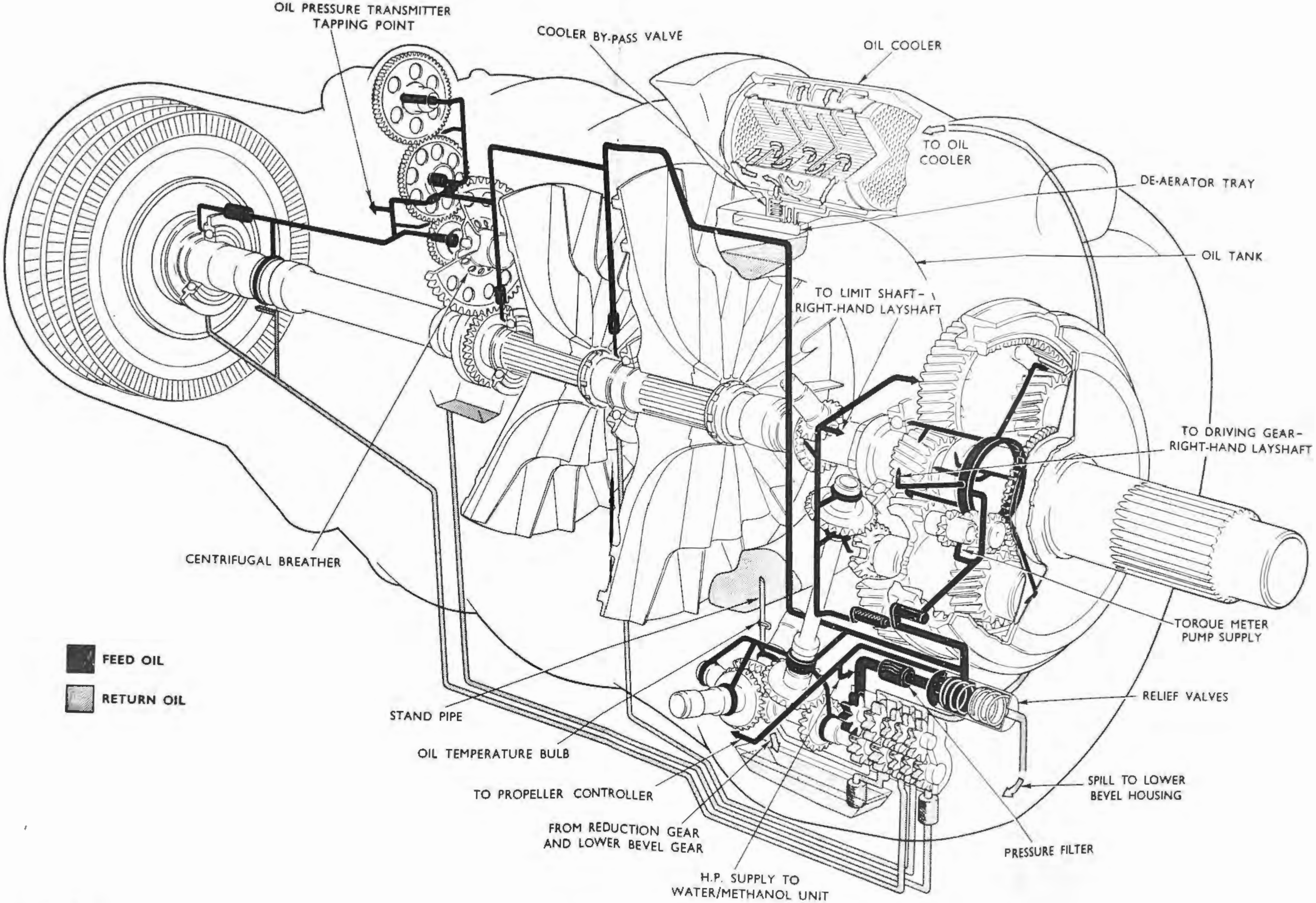
4.4.4.2 Oil Pressure Indicator

The oil pressure indicator is an instrument which indicates the oil pressure of both the right- and left-hand engines.
It operates on the 26-volt AC power, and is graduated from 0 to 40 psi.
It also has the following marking:

Red radial line	0 to 9 psi
Yellow radial line	9 to 14 psi
Green radial line	14 to 30 psi

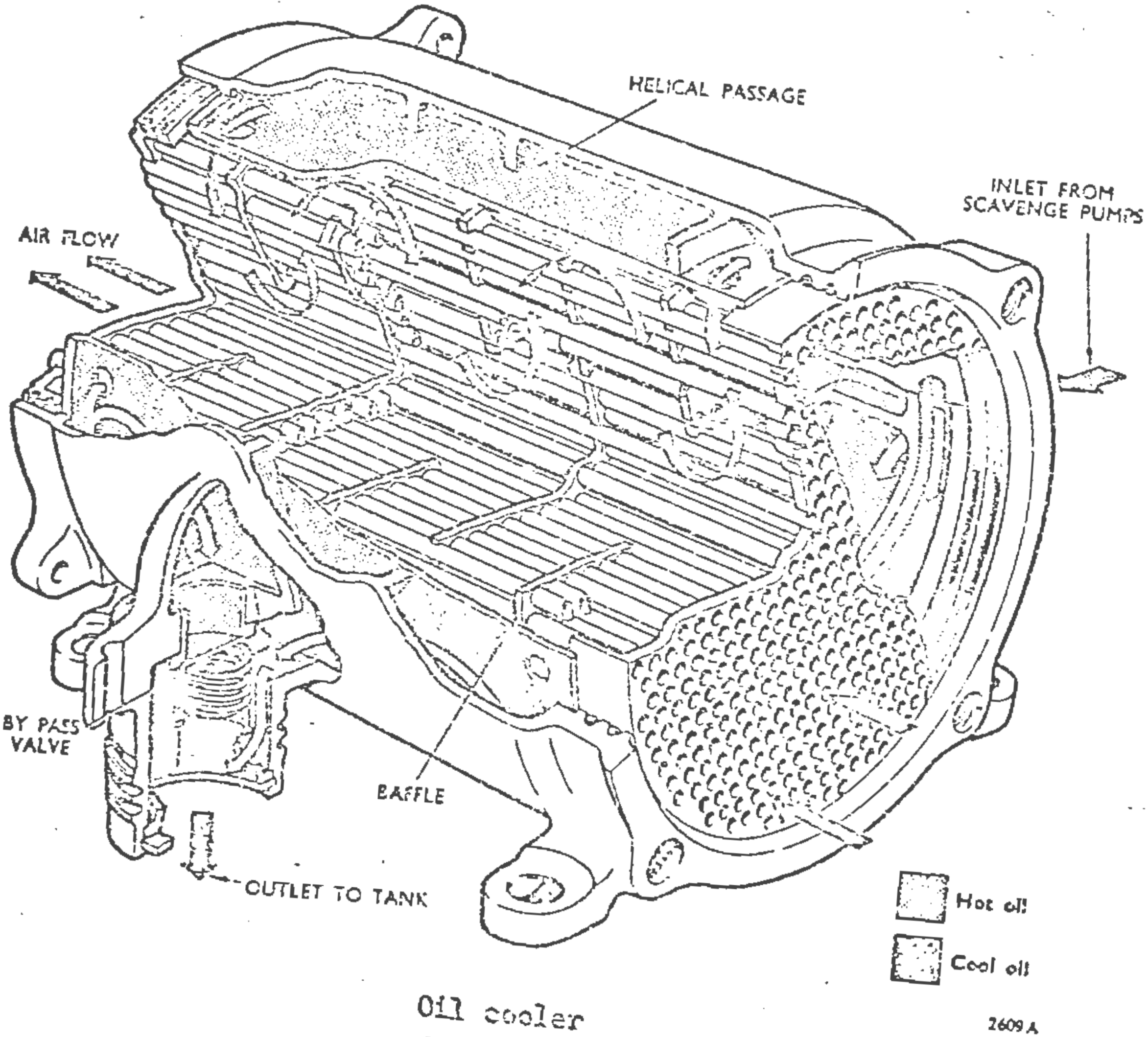
4.4.5 Oil System Data

Oil temperature: -30°C (min.) at engine start.
-10°C (min.) at engine start by using interal batteries.
-15°C (min.) in operation (over idling).

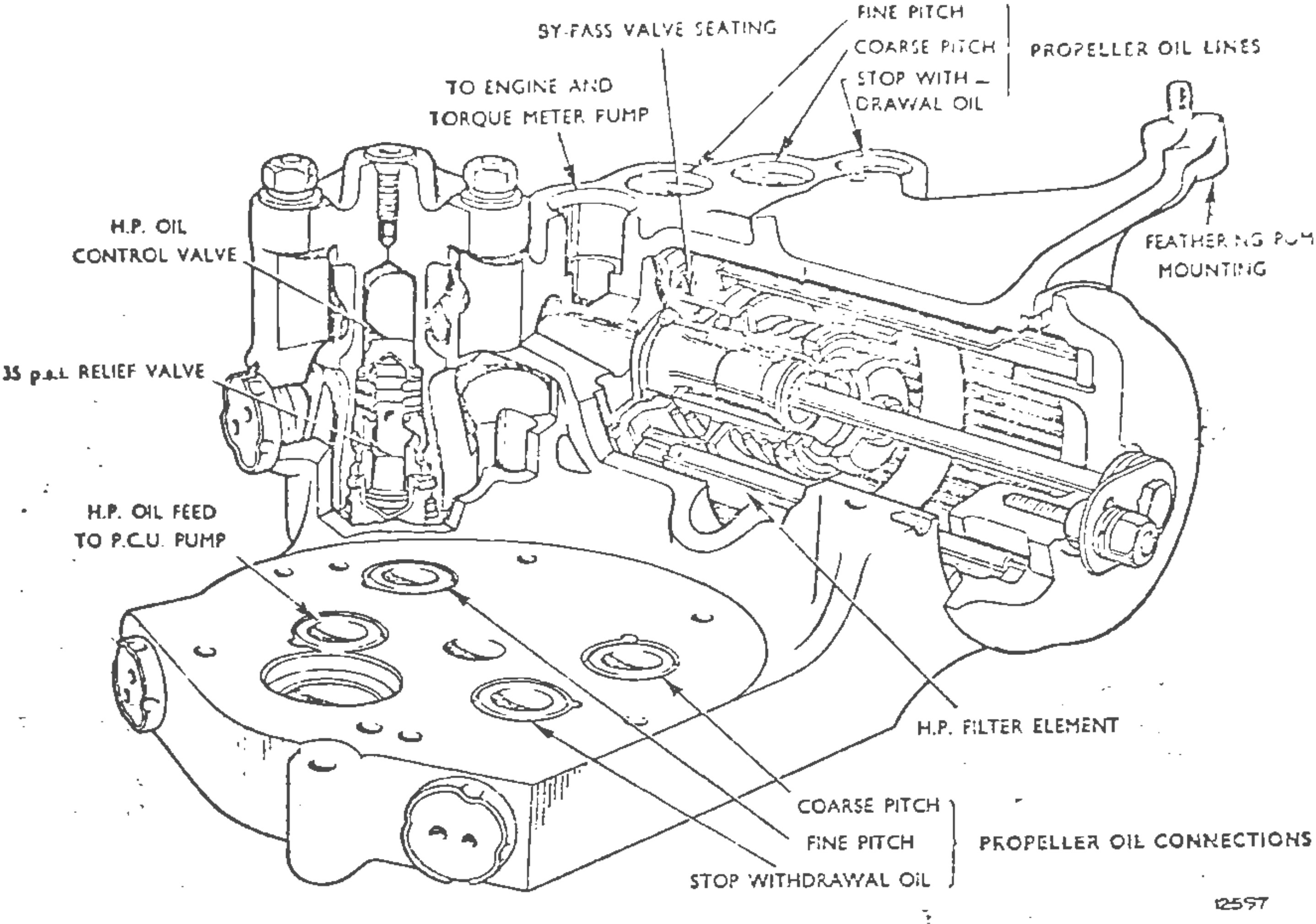

OIL PRESSURE TRANSMITTER TAPPING POINT
COOLER BY-PASS VALVE
OIL COOLER
TO OIL COOLER
DE-AERATOR TRAY
OIL TANK
TO LIMIT SHAFT-RIGHT-HAND LAYSHAFT
TO DRIVING GEAR-RIGHT-HAND LAYSHAFT
CENTRIFUGAL BREATHER
TORQUE METER PUMP SUPPLY
FEED OIL
RETURN OIL
RELIEF VALVES
STAND PIPE
OIL TEMPERATURE BULB
SPILL TO LOWER BEVEL HOUSING
TO PROPELLER CONTROLLER
FROM REDUCTION GEAR AND LOWER BEVEL GEAR
PRESSURE FILTER
H.P. SUPPLY TO WATER/METHANOL UNIT

OIL CIRCULATION DIAGRAM

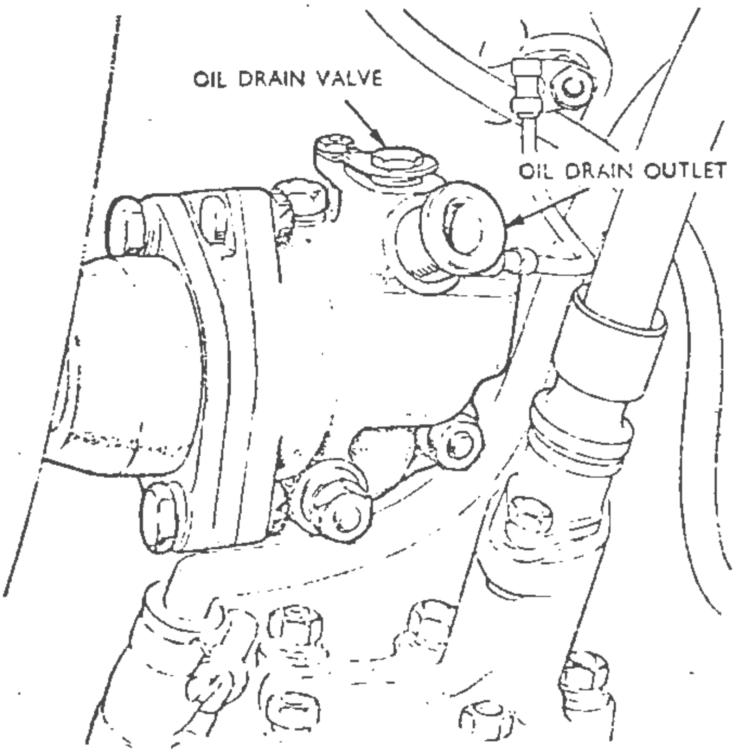
Fig. 4-22



Oil cooler
Fig. 4-23

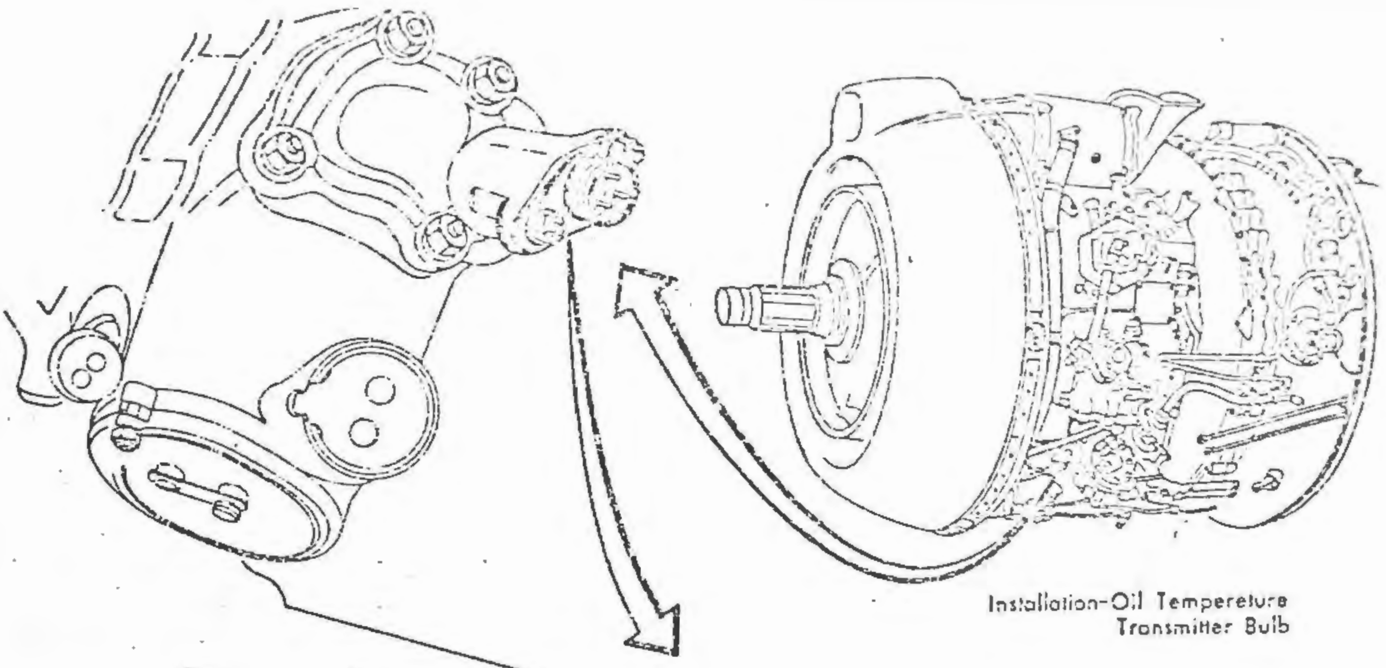


PRESSURE OIL FILTER AND RELIEF VALVE

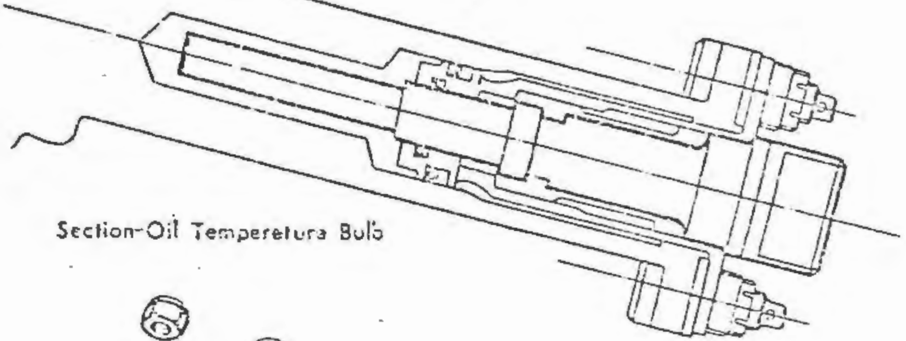


OIL TANK DRAIN

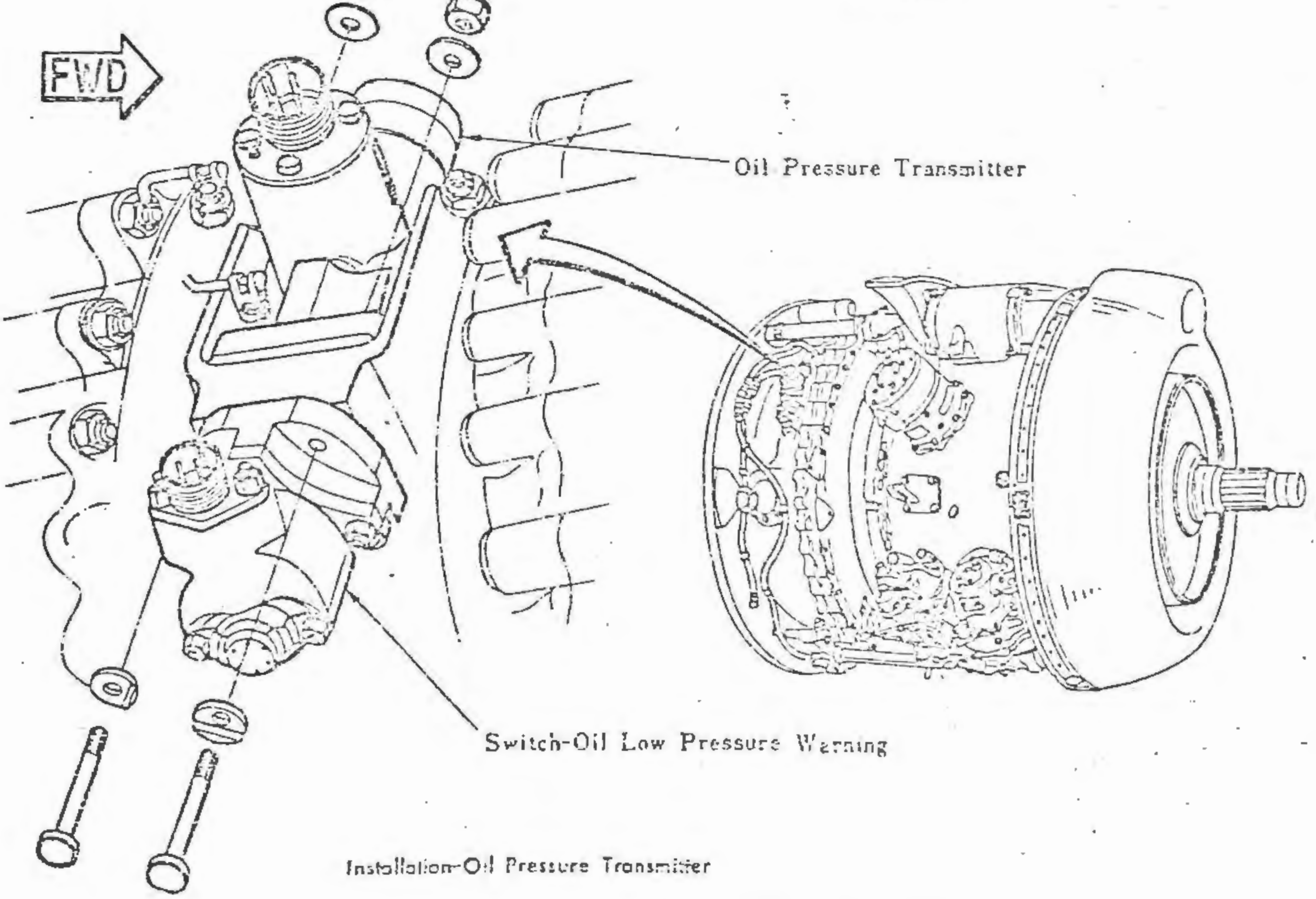
Fig. 4-24



Installation-Oil Temperature Transmitter Bulb



Section-Oil Temperatura Bulb



Installation-Oil Pressure Transmitter

Oil Temperature Bulb and Oil Pressure Transmitter
and Oil low Pressure Warning Switch

Fig. 4-25

	120°C (max.) in operation.
Oil pressure:	9 psi (min.) in operation (flight). 14 to 30 psi (normal) in operation. 5 to 6 psi for oil pressure warning.

4.4.6 Oil Replenishment

For measuring the oil level in the oil tank, a dipstick is fitted to the filler cap on the top of the oil tank. Accordingly no oil quantity gauge is provided in the cockpit, where, therefore, the oil level can not be checked during flight.
Oil consumption is very important for recognizing the engine condition and therefore the oil level must be checked after each flight.
The oil level must be measured within 10 to 30 minutes after the engines have stopped. This is because no accurate measurement of the oil level can be done due to the expansion of engines resulted from high temperatures and to the drainage characteristic of the oil system. If the oil level is below "FULL POSITION" on the dipstick, refill the oil up to "FULL" mark.
If earlier departure has necessitated the oil level check to be made within 10 minutes after engine stop, and if the oil level remains between the "FULL" mark and a 2-pint level, no oil refilling is necessary. Provided the oil has been consumed over 2 pints, refill up to the 2-pint level.
Oil consumption is about 0.2 to 0.5 U.S. pints/hour. If oil consumption exceeds 1/2 Imp. pints/hr (0.6 U.S. pint/hr), check for oil leaks.

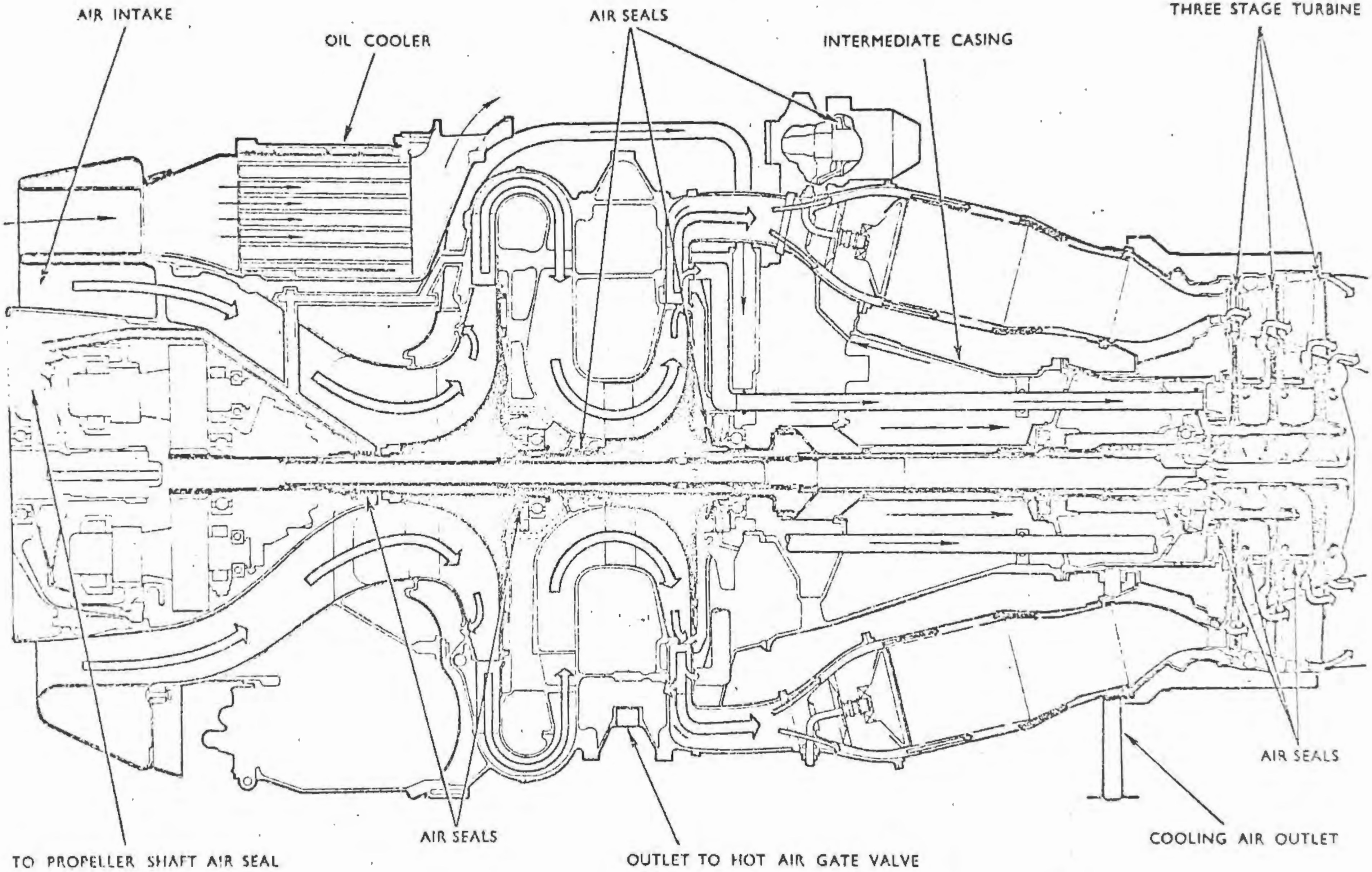
4.5 Cooling and Sealing Air Systems

4.5.1 General

The cooling air is taken out from several points around the circumference of the compressor and sent to each unit for cooling by dispersing the heat of the main gas stream. Besides, the air is used for various other purposes such as: pressurization of circumferential space formed by the labyrinth seals and the 2nd-stage compressor casing; removal of residual water/methanol fluid from the engine bleed air used in the air-conditioning system, hydraulic system, and other systems; and de-icing of the fuel filter. (Fig. 4-26)

4.5.2 Air Seals

The purpose of air seals is to control necessary air stream to prevent the entering of high-temperature main gas stream into the interior so that the bearing oil seals can work effectively. Most seals are of a labyrinth type. Oil seals are located between the oil and air seals, maintaining the pressure always higher than in the bearing chamber in order to prevent oil loss.
The labyrinth type seals are also employed for the prevention of hot gas leakage from the turbine into the interior and as well as the control of cooling air stream. In this type, the leakage of cooling air toward the hot gas is permitted but the hot gas leakage only is prevented.



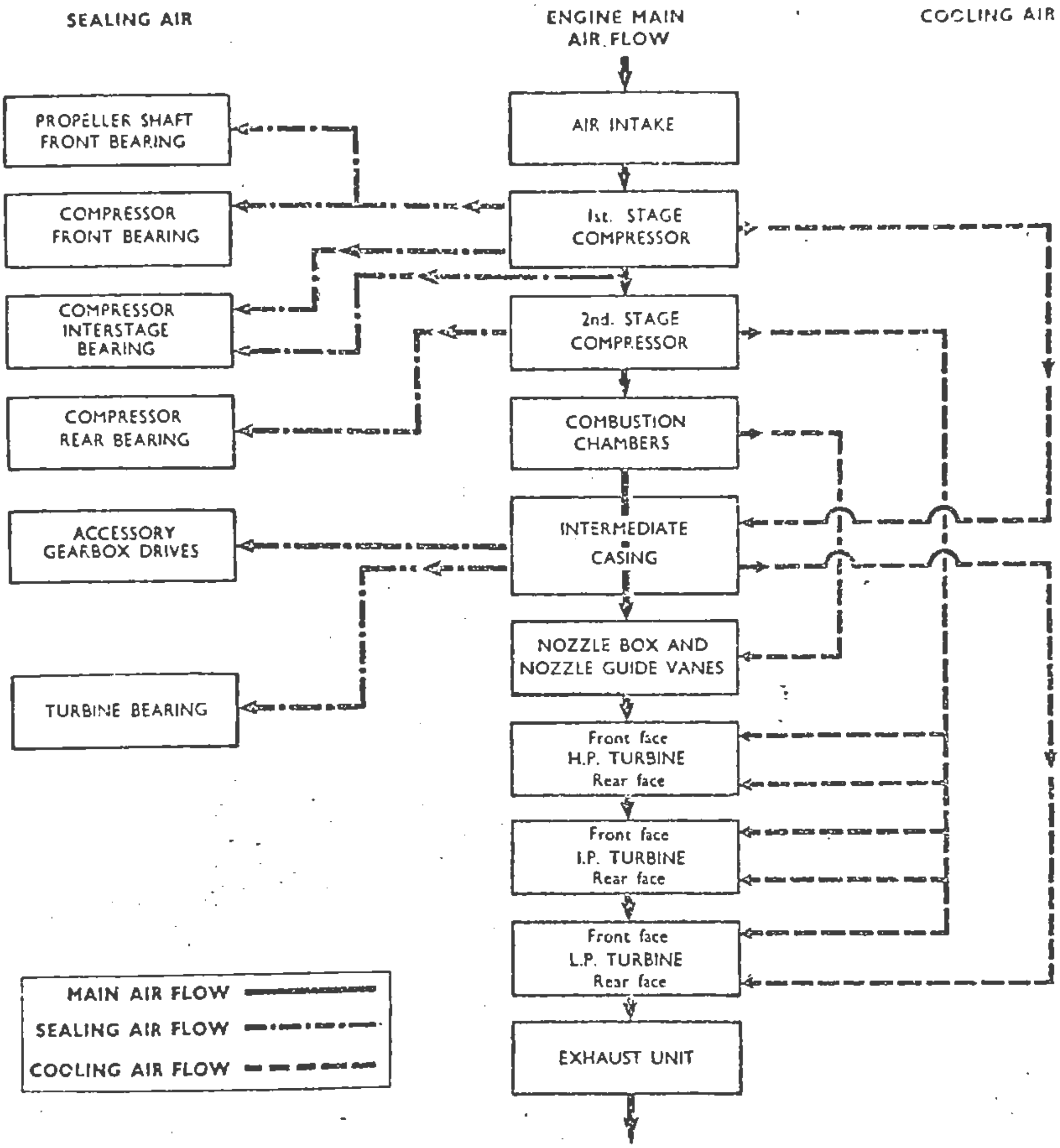
☐ LOW PRESSURE AIR

☐ HIGH PRESSURE AIR

SEALING AND COOLING AIR
Fig. 4-26

DART AIR COOLING AND SEALING SYSTEM

Basic Presentation

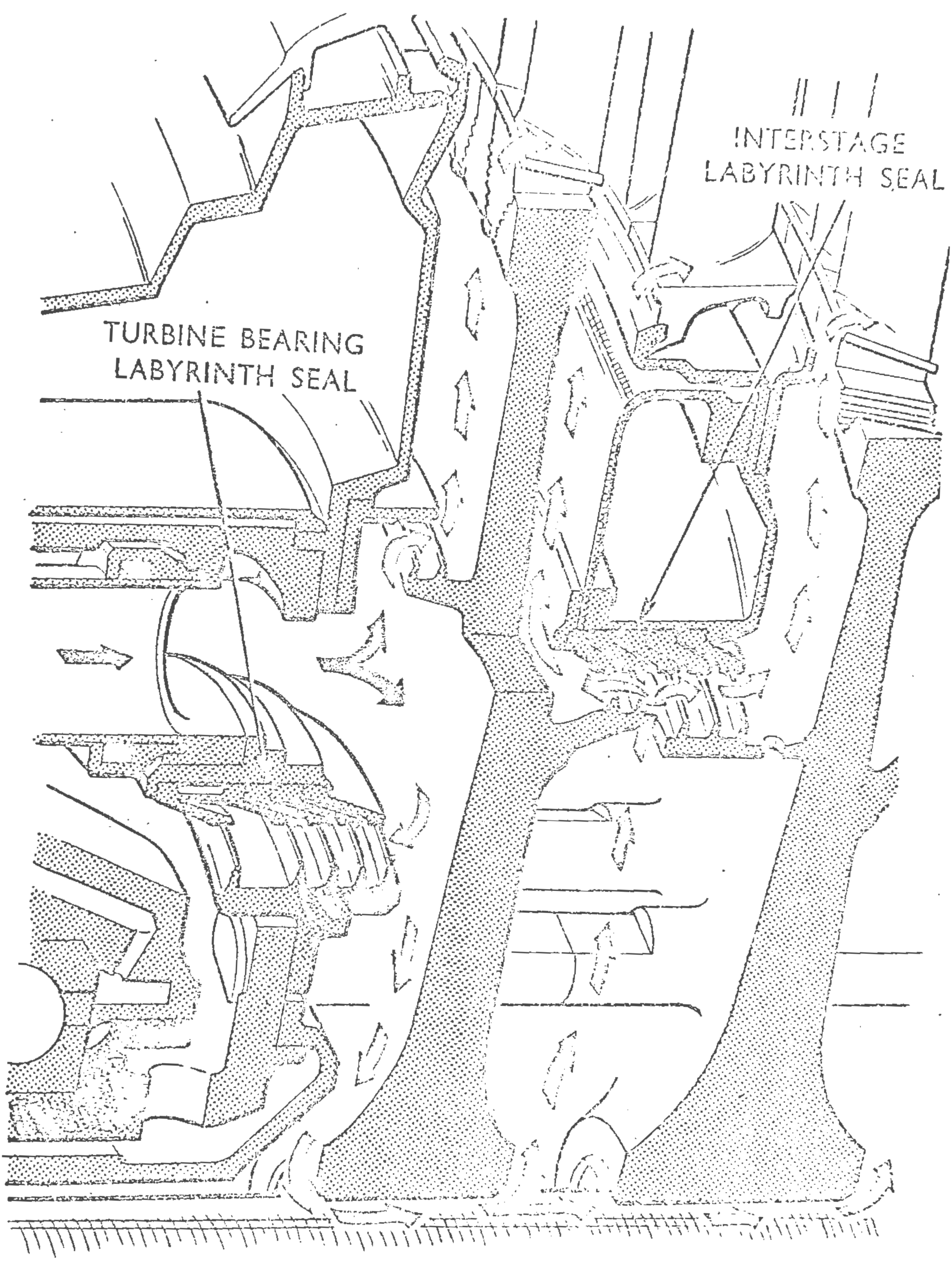


To prevent oil leaking away from the bearings, sealing air is taken to the bearing housings from the 1st. and 2nd. stage compressors.

To prevent overheating of the nozzle box, nozzle guide vanes and turbines, cooling air is fed to them from the 1st. and 2nd stage compressors.

DART AIR COOLING AND SEALING SYSTEM—BASIC PRESENTATION

Fig. 4-27



COOLING AND SEALING H.P. TURBINE DISC

Fig. 4-28

4.5.3 Air Stream

Cooling and sealing air streams are shown in Figs. 4-26 and 27.
The high-pressure air also pressurizes space round the circumference of the compressor intermediate casing, reducing the casing stress caused by pressure difference between stages.
The air taken out from the compressor intermediate casing flows through the gate valve to the fuel filter de-icing unit.

4.6 Torquemeter System

4.6.1 General

When torque is being applied to the propeller shaft, axial thrust occurs between the helical teeth of the three layshaft driving gear and the high-speed pinion and also between the helical teeth and the annulus gear of the propeller shaft. This thrust is proportional to the torque being applied to the shaft. This thrust is balanced with oil pressure called the torquemeter pressure and, by measuring this torquemeter pressure, the engine power can be known. This measurement is done by means of the torquemeter system. (Fig. 4-30)
The general description of the reduction gear is given in the paragraph 4.1.3.

4.6.2 Use of Torquemeter System

Torquemeter pressure is used for the following purposes for the indication of the engine power.

(1) Indicates torquemeter, on the basis of which the pilot can calculate take-off power.

(2) Serves as an element of the water/methanol control on wet take-off.

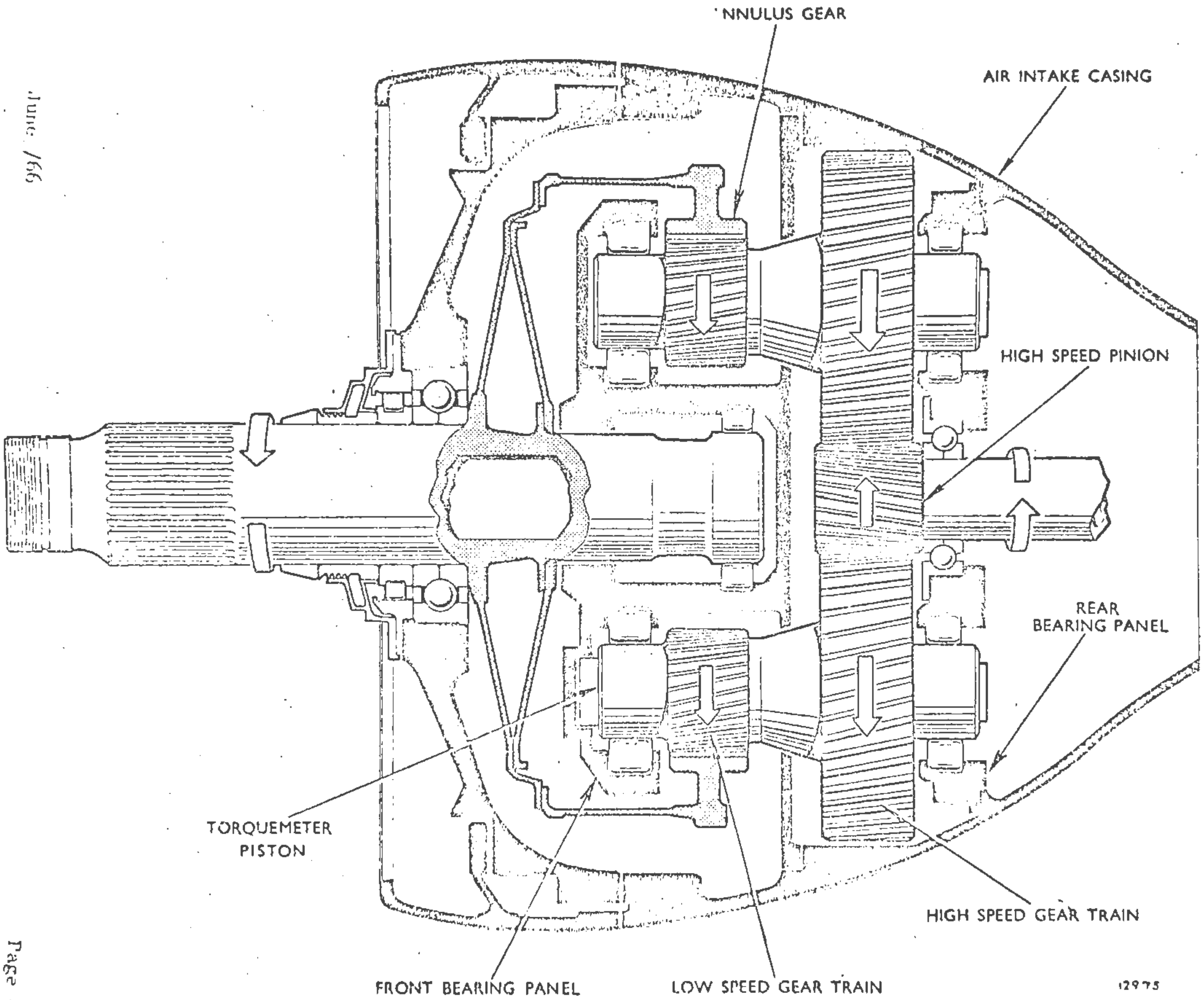
(3) Serves as an element for auto-feathering the propellers by operating the low torque switch in the event of engine trouble.

(4) Balances the forward thrust of the layshaft.

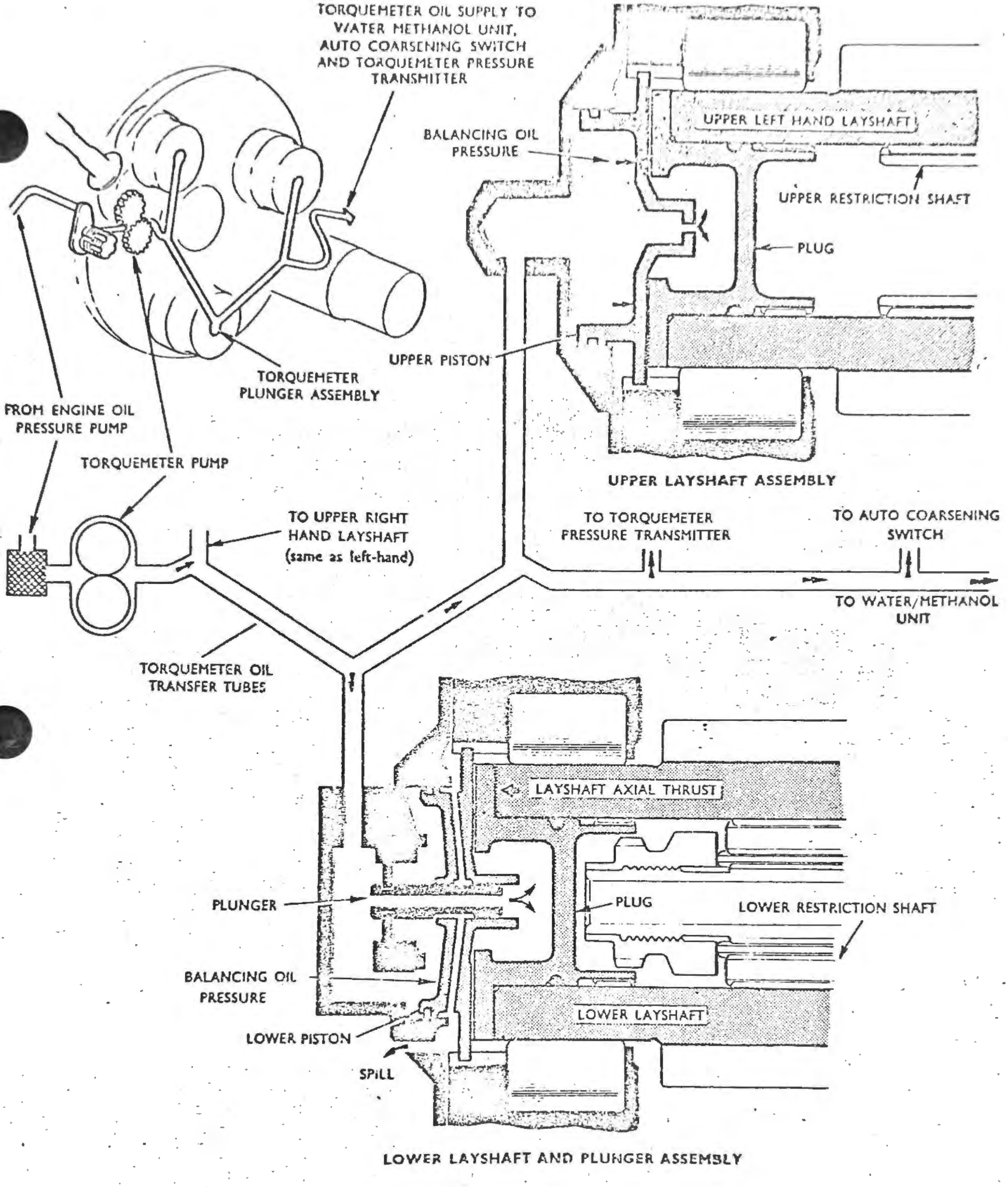
This torquemeter system, however, is not accurate; and accordingly it can not be used as a precision instrument for engine control. This may be used only as a guide to see if the engines are running in a satisfactory operating condition or for changing the engine power.

4.6.3 Construction

Each layshaft has a thrust pad on its top end and a piston against the thrust pad. To this piston, the oil is supplied by means of the gear type torquemeter oil pump; and accordingly the oil pressure and the forward thrust of the layshaft are balanced. The lower layshaft is provided with a plunger assembly whereby the torquemeter oil pressure is adjusted. (Fig. 4-29)



REDUCTION GEAR


TORQUEMETER OIL SUPPLY TO WATER METHANOL UNIT, AUTO COARSENING SWITCH AND TORQUEMETER PRESSURE TRANSMITTER
BALANCING OIL PRESSURE
UPPER LEFT HAND LAYSHAFT
UPPER RESTRICTION SHAFT
PLUG
UPPER PISTON
TORQUEMETER PLUNGER ASSEMBLY
FROM ENGINE OIL PRESSURE PUMP
TORQUEMETER PUMP
UPPER LAYSHAFT ASSEMBLY
TO UPPER RIGHT HAND LAYSHAFT (same as left-hand)
TO TORQUEMETER PRESSURE TRANSMITTER
TO AUTO COARSENING SWITCH
TO WATER/METHANOL UNIT
TORQUEMETER OIL TRANSFER TUBES
LAYSHAFT AXIAL THRUST
PLUNGER
PLUG
LOWER RESTRICTION SHAFT
BALANCING OIL PRESSURE
LOWER LAYSHAFT
LOWER PISTON
SPILL
LOWER LAYSHAFT AND PLUNGER ASSEMBLY

TORQUEMETER OPERATION

Fig. 4-30

With an increase in engine torque, the layshaft moves forward. Since oil spilling through the plunger decreases, the torquemeter oil pressure increases. When the engine speeds increase, the oil pressure from the pump also increases; but the amount of oil spill from the plunger becomes greater to balance with the forward thrust of the layshaft.
Under a fixed power condition, layshaft thrust and torquemeter pressure are balanced and the plunger is in the position where this balance is maintained. This balanced oil pressure is utilized by the torquemeter pressure transmitter, water/methanol unit, and low torque switch. Owing to the balancing mechanism using a plunger, hunting may in some cases occur, resulting in fluctuation on torquemeter. In such a case, decrease the power to reduce the torque once to about 50 psi and the hunting will stop.

4.6.4 Low Torque Switch

The low torque switch is of a diaphragm type, which operates at the torque pressure of 40 to 50 psi, completing the auto-feathering circuit.

4.6.5 Torque Pressure Indicator

Torque pressure is indicated by an indicator consisting of a DC desyn and a Bourdon's tube. The indicator is graduated from 0 to 500 psi and provided with a yellow arc marking from 0 to 40 psi.

4.7 Compressor

4.7.1 General

The compressor is of a single entry, 2-stage, centrifugal type and is directly coupled with the turbine.
The compressor casing is composed of the three principal parts as shown below and has inside the rotating assembly and the 1st- and 2nd-stage diffuser rings.
The three principal parts are:

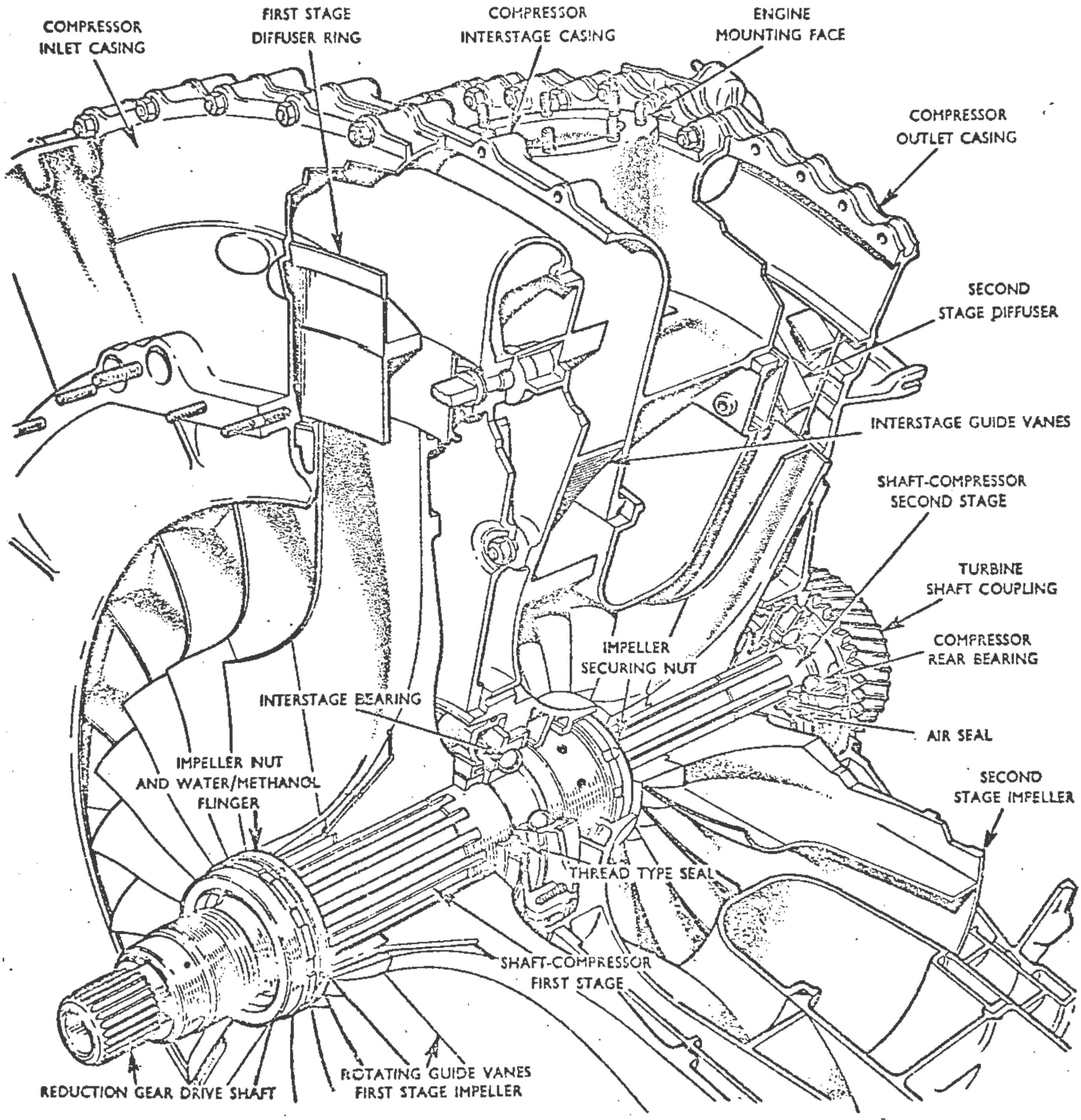
Inlet casing .... (1st-stage diffuser ring)
Interstage casing ..... (Engine mounting feet)
Outlet casing .... (2nd-stage diffuser ring)

Refer to Para. 4.1.5.

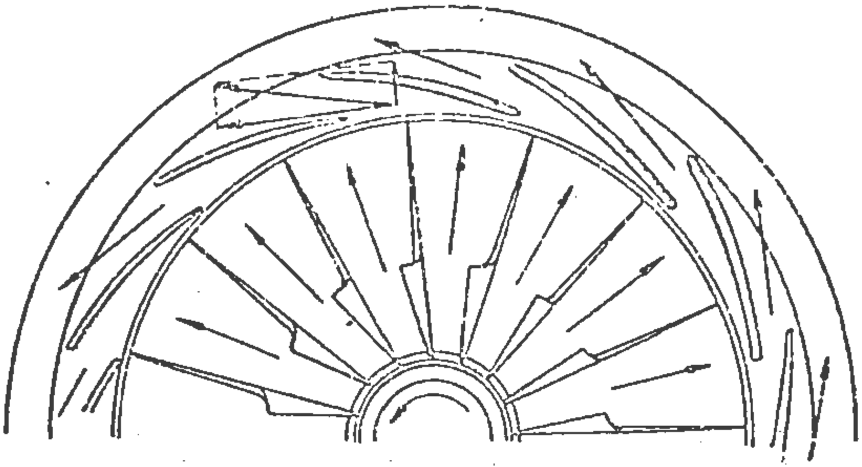
Compression ratio at the maximum speed under the I.S.A. condition is about 6.250 : 1.
Inside the compressor is built the water/methanol unit for injection of water/methanol fluid so that a constant take-off power may be obtained within the range of temperatures from -20°C up to +30°C I.S.A.

4.7.2 Operation

The air pressure is increased by the centrifugal force of the two impellers. The air going into the compressor increases its speed when passing through the air intake and flows through the rotating guide vane. The air in the impellers is forced outward by the centrifugal force and flows through the

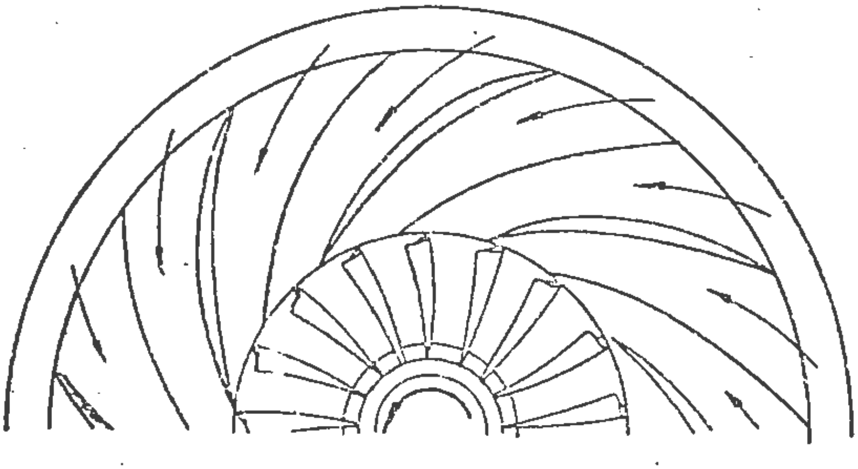


COMPRESSOR
Fig. 4-31



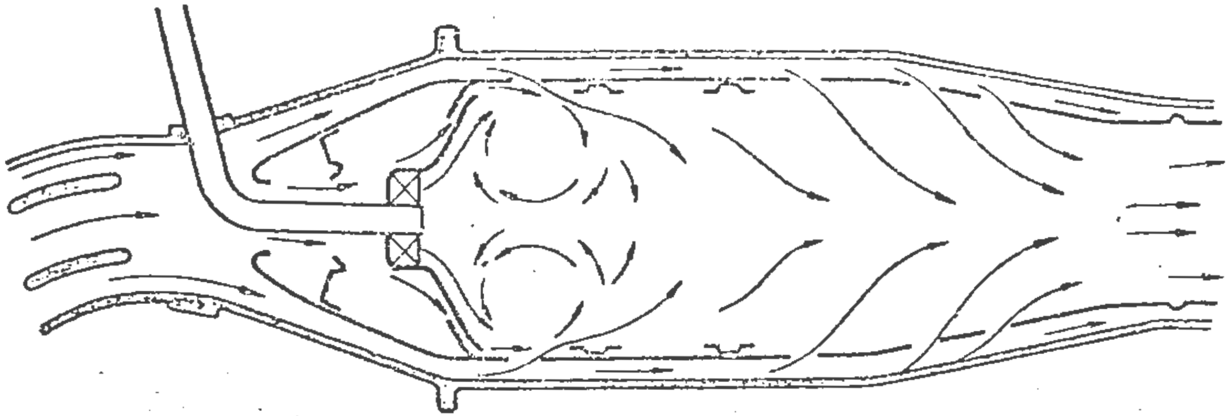
Air Flow Through Diffuser

Fig 4 — 32



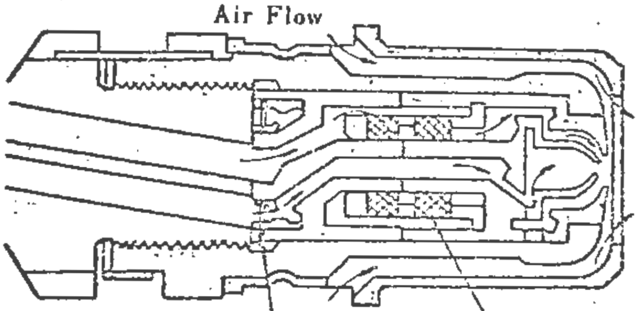
Air Flow Through Interstage Guide Vanes

Fig 4 — 33



Flame Stabilization & Air Flow Diagram

Fig 4 — 35



Fuel Burner

Fig 4 — 36

diffuser ring, decreasing its velocity and increasing its pressure.
The air pressurized by the 1st stage compressor goes into the interstage casing to be streamlined by the guide vane, flowing into the 2nd stage, where the air pressure is further increased. Then it flows into the outlet elbow for flow regulation, finally being sent into the combustion chamber. (Figs. 4-32 and 33)

4.8 Combustion Chamber

4.8.1 Construction

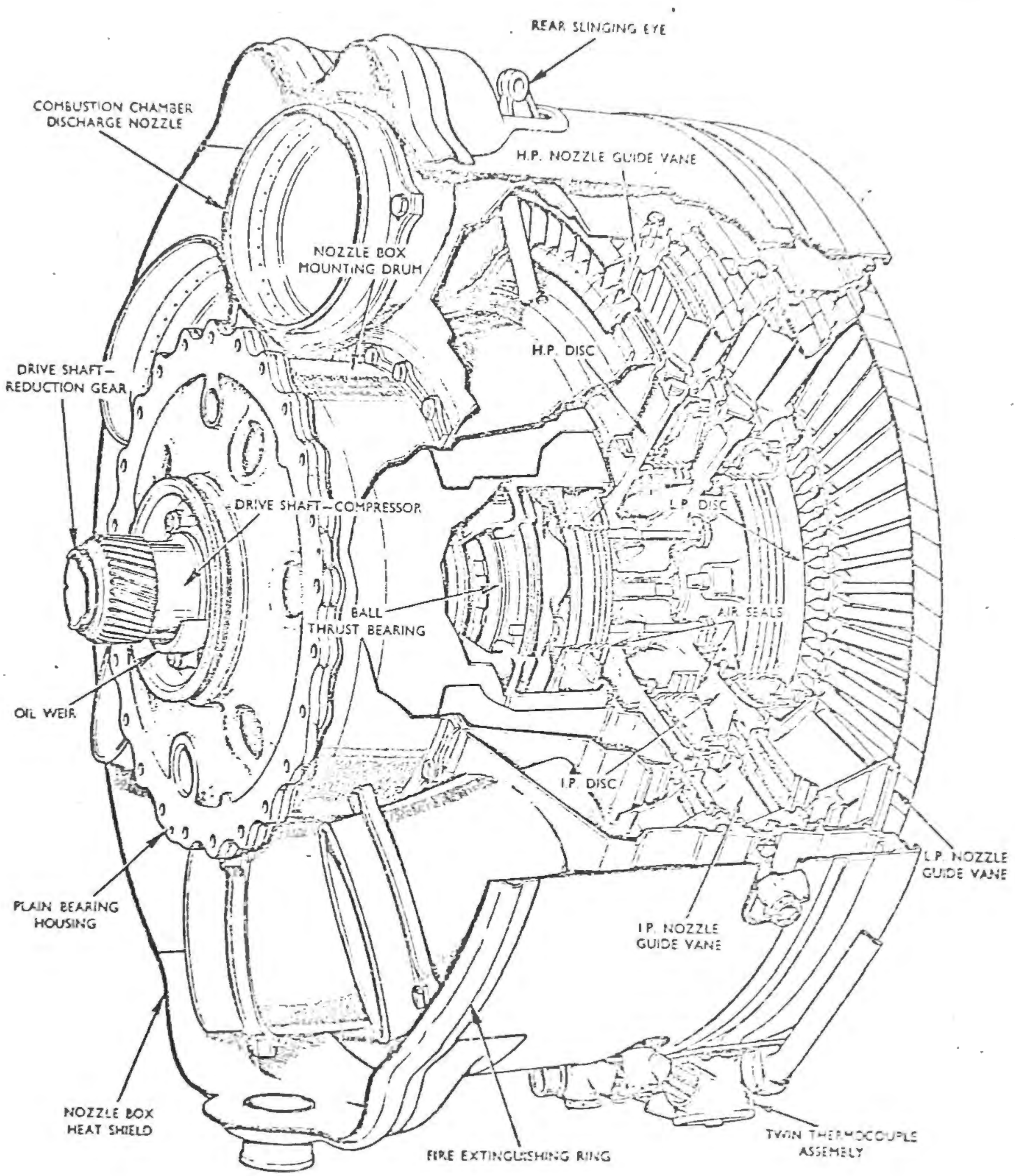
In this engine are provided seven combustion chambers between the compressors and turbine nozzle boxes. They are fitted around the intermediate casing at an angle of 7-1/2° against the main drive shaft and serve to permit smooth air flow and to reduce the overall length of the engine.
The combustion chambers are numbered counterclockwise as viewed from the rear, with No. 1 chamber starting from one fitted to the inlet elbow located on the top on the right-hand side of the accessory gear box drive.
Nos. 3 and 7 combustion chambers are provided with igniter plugs.
Each combustion chamber, bolted to a cast expansion chamber, is of a double wall construction having an air casing and a flame tube inside.
The fuel burner is attached to the expansion chamber to inject the fuel into the center of the flame tube.
At the time of engine start, Nos. 3 and 7 chamber igniter plugs are used to ignite the engine. When ignited, flames are spread into each chamber by means of the interconnector tube.
The residual fuel, in the combustion chamber, resulted from a failure of engine start, or fuel leaks from the burner, is removed from the drain valve on No. 5 chamber by means of the drain system.

4.8.2 Combustion

The air flowing from the compressor into the expansion chamber is divided into two streams: one, about 20%, enters the flame tube and the other passes through the gap between the flame tube and the air casing.
The flame tube air flows through the swirl vane and surrounding flare, decreasing its velocity to facilitate mixing of air and fuel. Here, the fuel burns and its gas temperature reaches as high as 2,000°C. The hot gas, however, is cooled to an appropriate temperature by the air coming in through holes around the flame tube before reaching the flame tube wall and the turbine. (Fig. 4-35)

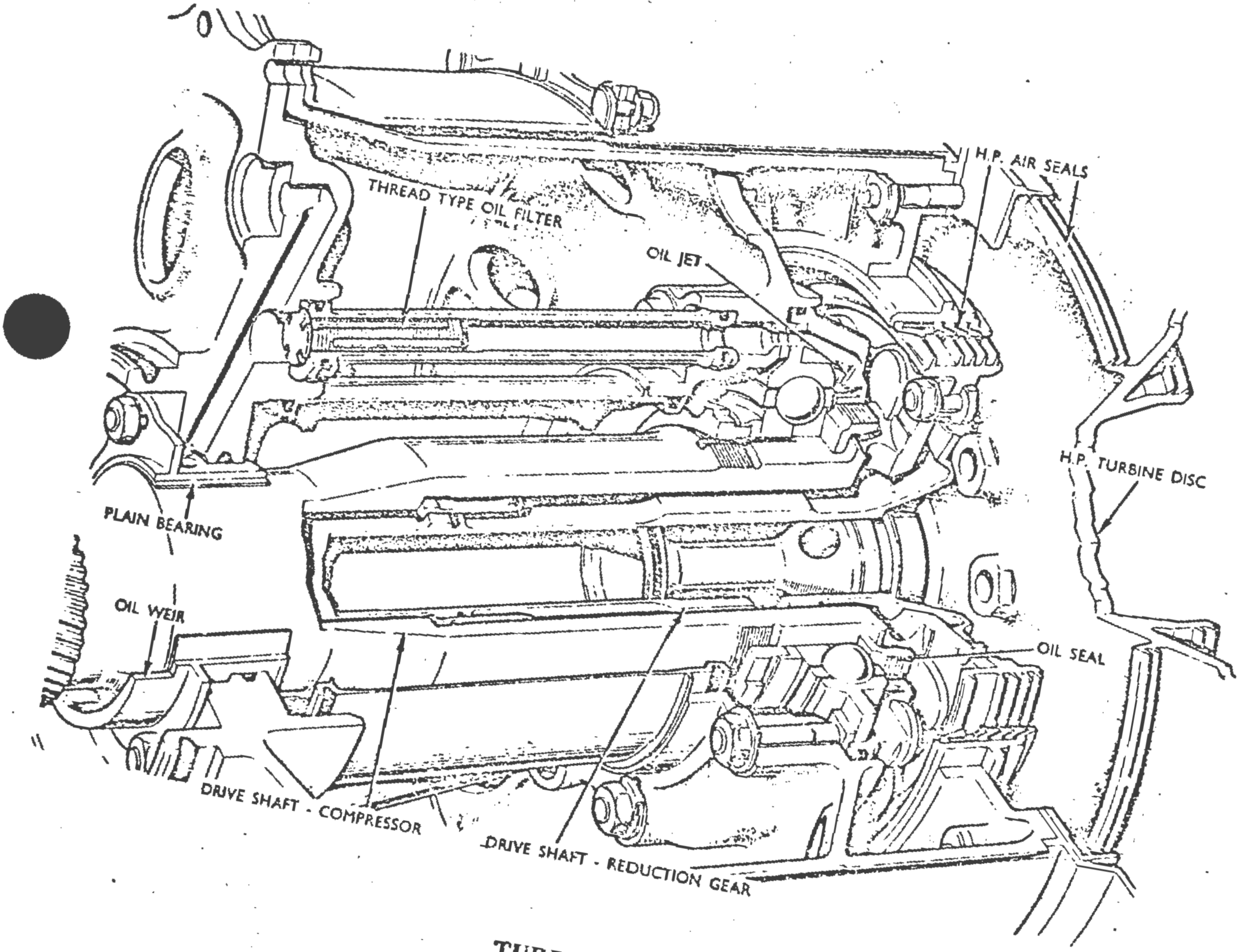
4.8.3 Fuel Burner

The burner atomizes the fuel and sends it into the flame tube. Each combustion chamber is provided with a duple burner with a couple of nozzles so that satisfactory fuel combustion can be ensured throughout the engine operating range.
In the case of low fuel flow as in engine start, the fuel is injected from the primary nozzle at the center of the burner. With increase of fuel flow, the fuel is controlled inside the F.C.U. so fuel injection will be done also from the main nozzle.



Nozzle box and turbine

Fig. 4-37



TURBINE BEARING

Fig. 4-38

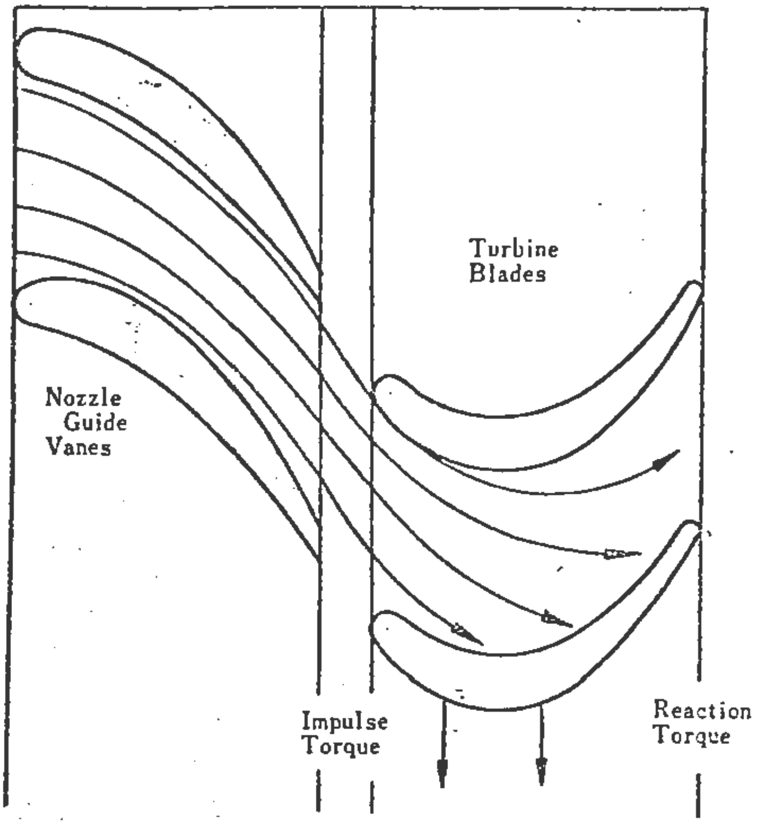
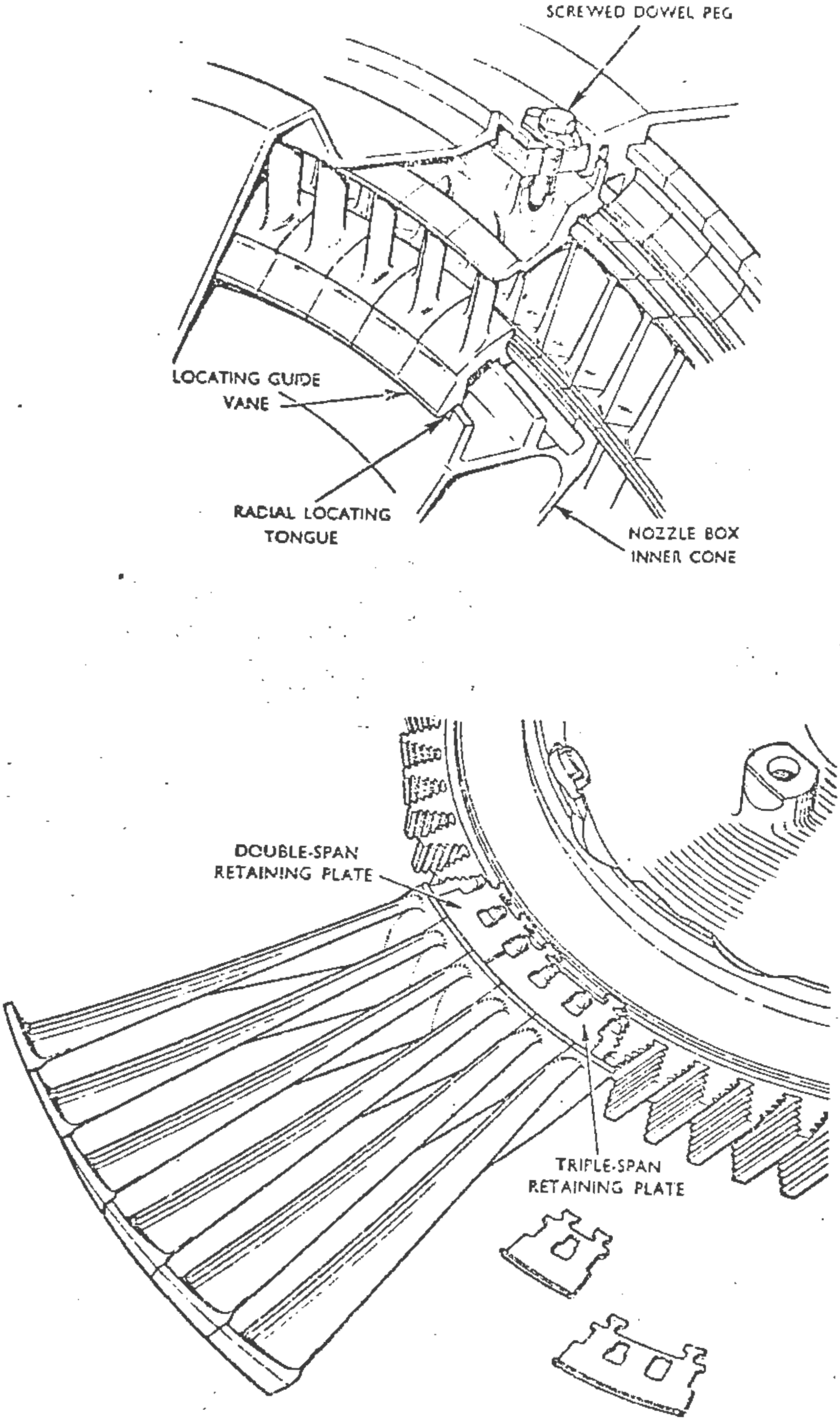

Turbine Blades
Nozzle Guide Vanes
Impulse Torque
Reaction Torque

Fig 4 — 39



TURBINE ASSEMBLY DETAILS

Fig. 4-40

Around the nozzle is an air outlet, through which the air is let out to prevent carbon from attaching to the nozzle. (Fig. 4-36)

4.9 Turbine and Exhaust

4.9.1 Construction

The high-speed gas coming out from the combustion chamber flows through the seven discharge nozzles into the turbine.
Most of the hot gas energy is converted into mechanical energy by the turbine, being transmitted to the engine main shaft to drive the propellers, compressors, and accessory unit.
Residual gas energy, small in quantity, is ejected rearwards to be utilized as thrust.
The turbine section consists of the following.

Nozzle box
High pressure turbine (H.P.)
Intermediate pressure turbine (I.P.)
Low pressure turbine (L.P.)
Exhaust unit

4.9.2 Nozzle Box

The nozzle box has H.P., I.P., and L.P. nozzle guide vanes and discharge nozzles to deliver the gas from the combustion chamber to the turbine through the H.P. nozzle guide vanes.

H.P. N.G.V.	70 vanes
I.P. N.G.V.	56 vanes
L.P. N.G.V.	56 vanes

The I.P. nozzle guide vanes are fitted with thermocouples for the measurement of turbine gas temperature.

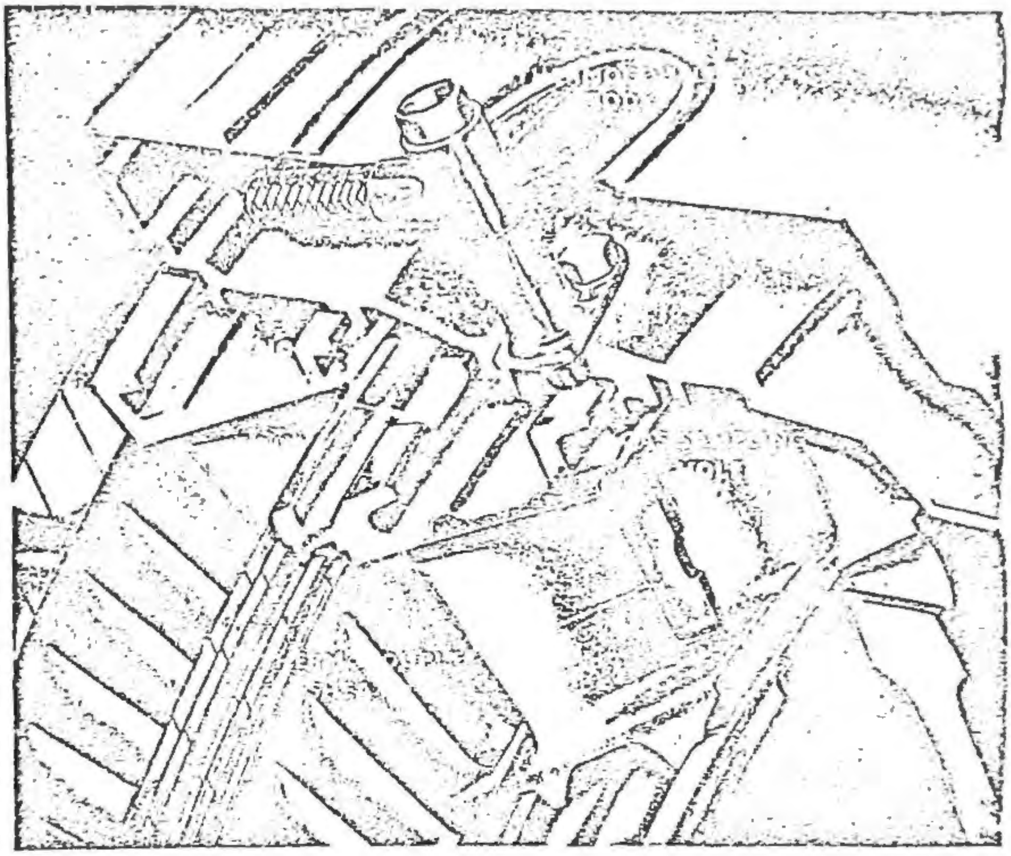
4.9.3 Turbines

Three turbine discs are attached to the turbine shaft assembly by 10 bolts. Around each disc are fitted vane-type blades at a certain angle. Velocity and direction of the high-speed gas flow is changed by the blades, producing thrust.

H.P. turbine	131 blades
I.P. turbine	97 blades
L.P. turbine	73 blades

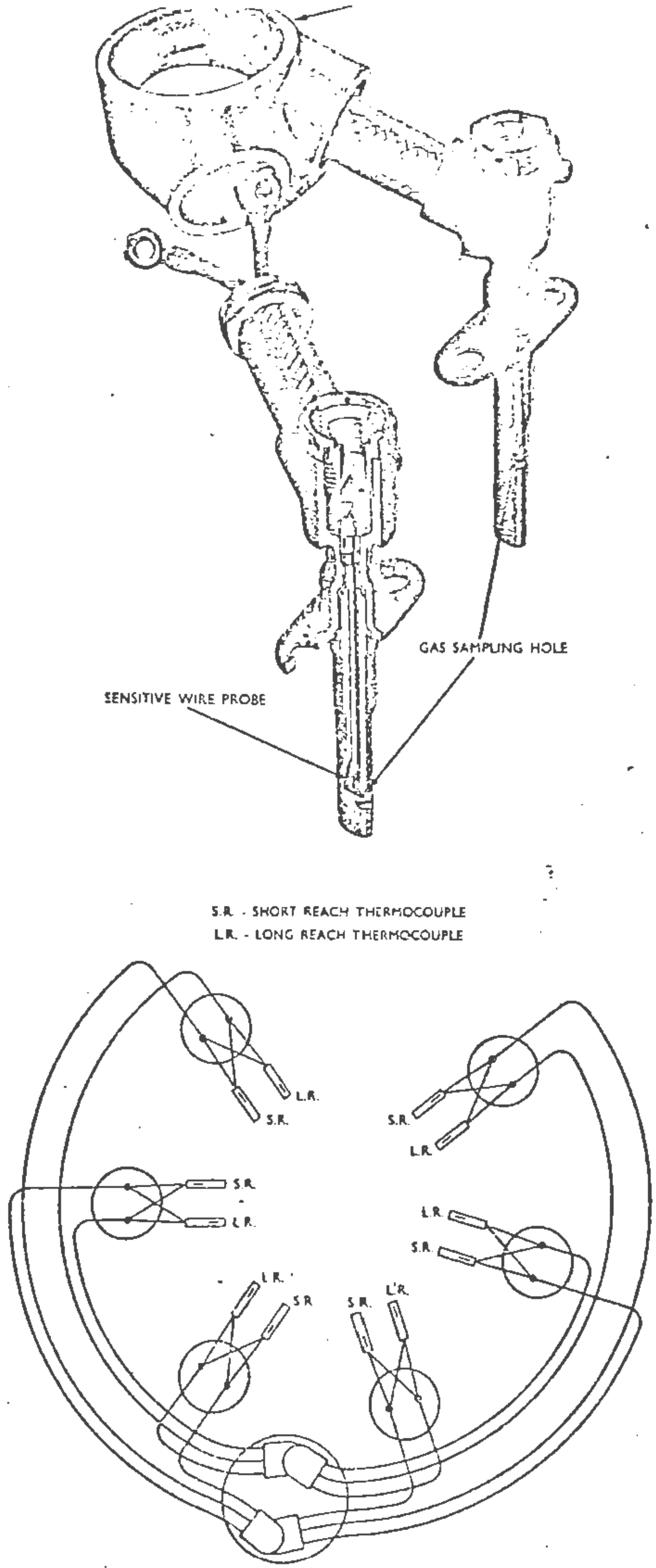
4.9.4 T.G.T. Indicator

For the measurement of engine gas temperature, the pyrometric system is employed.
The pyrometric system is of such a design that its thermocouple is fixed in the 2nd stage of the turbine for the measurement of T.G.T. and the measured value is indicated by an indicator in the cockpit.



THERMOCOUPLE IN INTERMEDIATE NOZZLE GUIDE VANE

Fig. 4-42



TWIN THERMOCOUPLE ASSEMBLY

Fig. 4-43

The thermocouple is an alumel (-) chromel (+) thermocouple assembled in magnetism, two pieces making a set. Six sets of the alumel-chromel thermocouples are attached around the nozzle box, each connected in parallel. The T.G.T. indicator is a millivolt meter, which converts an electric signal sent from the thermocouple into temperature and indicates it by the centigrade scale.
The indicator is graduated from 60°C up to 1,000°C with 20-degree intervals, and carries the following marking.

Green arc	550°C to 820°C
Yellow arc	820°C to 865°C
Red arc	865°C to 890°C
Red radial line	890°C

4.9.5 Exhaust Unit

The exhaust unit is bolted to the nozzle box. This unit serves to control exhaust gas flow in order to keep turbine back pressure as low as practicable. This function is very important for improving turbine efficiency. The exhaust unit is composed of two cylindrical cones, inner and outer, of heat-resisting steel plate. The gap between the inner and outer cones grows wider as it goes rearwards, whereby back pressure is reduced.
Gas ejected from the exhaust unit flows out after passing through the tail pipe.

4.10 Fuel Control System

4.10.1 General

The engine power is determined by the air mass flow and the turbine entry gas temperature. This gas temperature is obtained by fuel combustion. The fuel system controls the fuel flow for the purpose of obtaining a satisfactory fuel-air mixture throughout the engine operating range.
The fuel system is employed to meet the following requirements.

Effective fuel atomization throughout the fuel flow range. ..... Burner

Control of fuel supply by the pump to the quantity required by engines.

Fuel flow change in proportion to throttle opening.

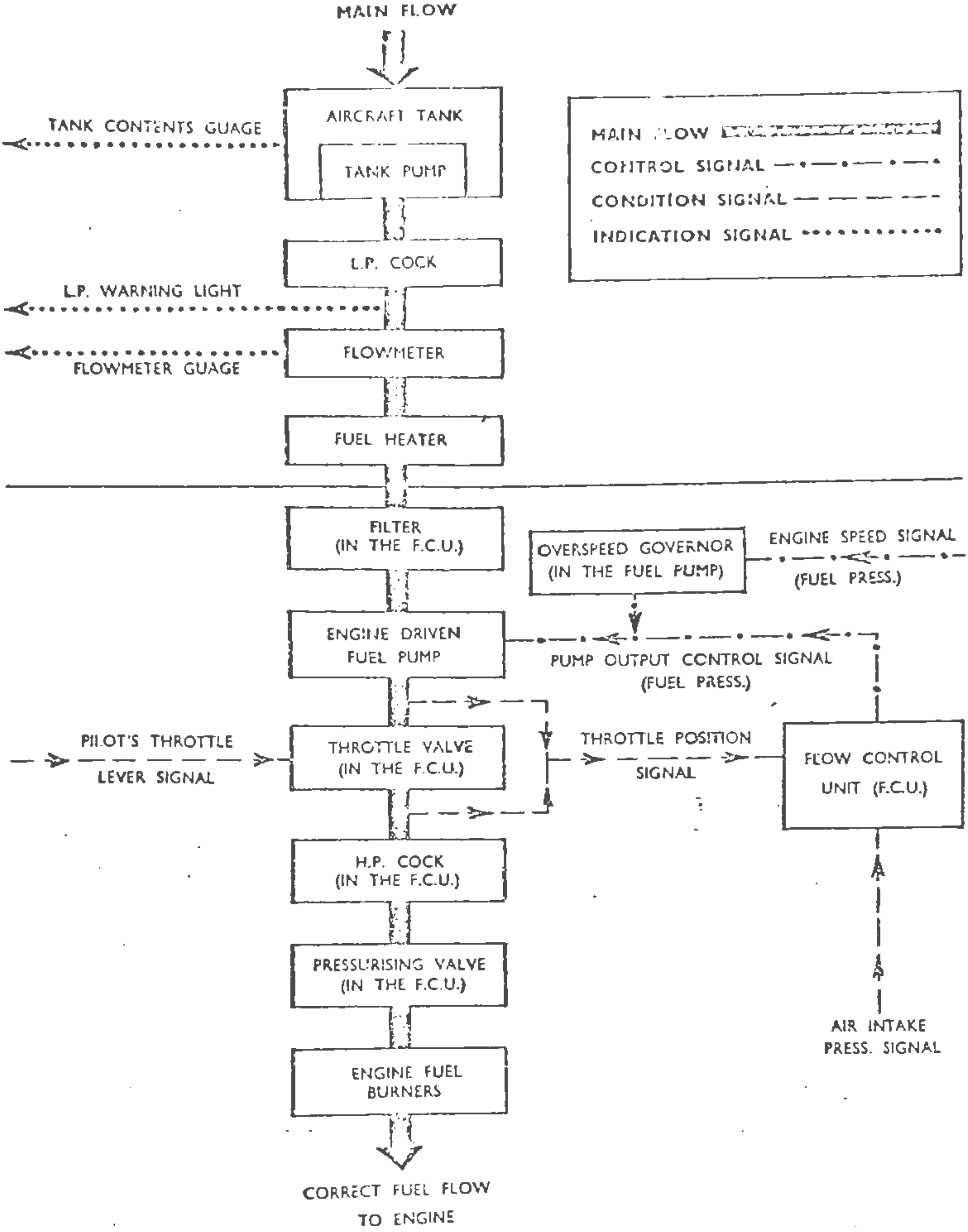
Fuel flow change in accordance with the intake air condition.

Maximum fuel flow control to ensure engines power limitation.

Idling fuel flow control.

Engine stop .........H.P. cock.

Engine overspeed control.



The main fuel flow is regulated by the control system.

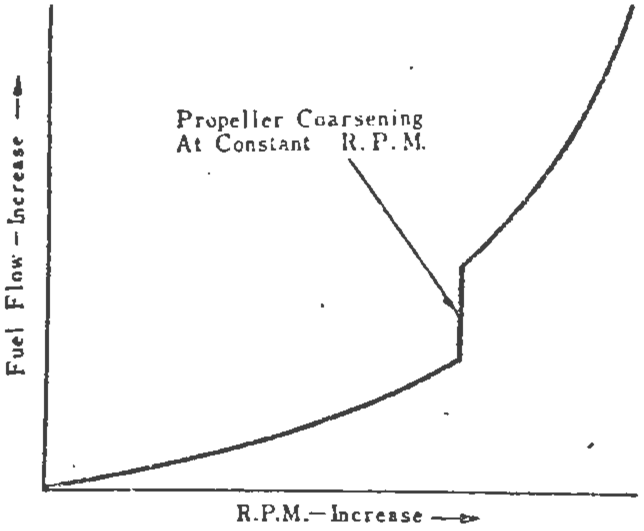
The principle is that the engine fuel pump output is adjusted by a signal from the Flow Control Unit.

The Flow Control Unit receives signals of throttle position and air intake pressure.

Correct fuel flow is thus maintained to suit engine requirements.

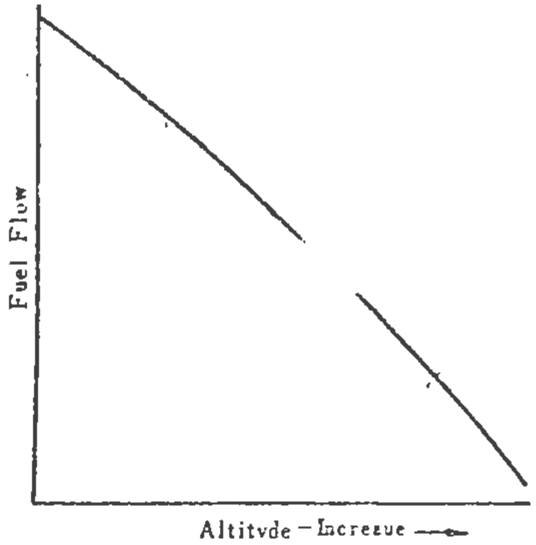
DART FUEL SYSTEM — BASIC PRESENTATION

Fig. 4-44



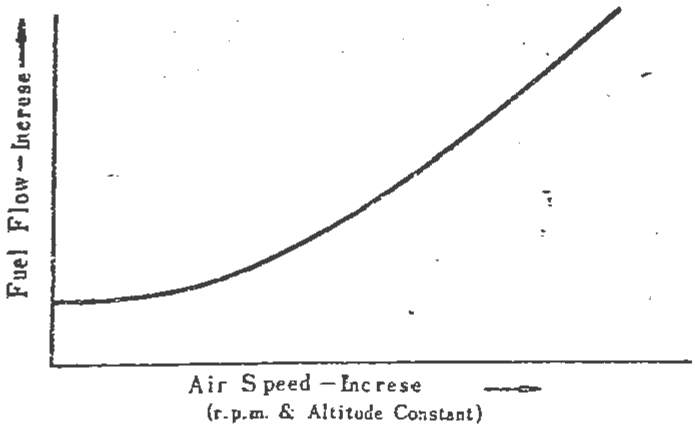
Variation of fuel flow with engine r.p.m.

Fig 4 — 45



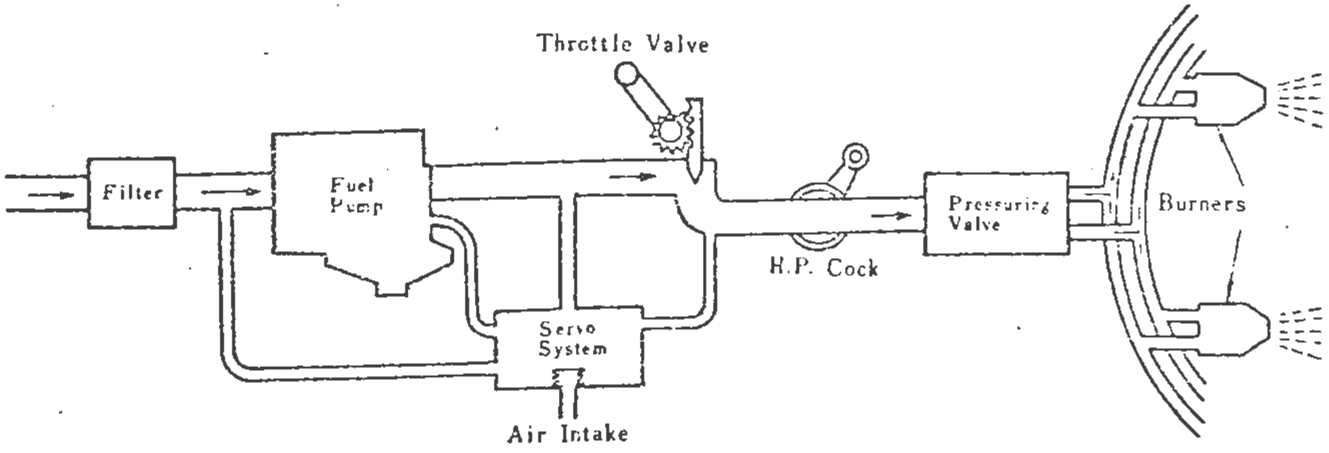
Variation of Fuel Flow with Altitude

Fig 4 — 46



Variation of Fuel Flow with Forward Speed

Fig 4 — 47



Fuel Flow Diagram

Fig 4 — 48

The fuel system is, as shown in Fig. 4-44, made up of burner, fuel pump and flow control unit (F.C.U.). In the flow control unit are built the throttle valve and high-pressure cock. Besides, a fuel filter is fitted to trap small foreign substances present in the fuel; and the fuel heater is adopted to prevent freezing of water contents in the fuel during cold weather.

4.10.2 Fuel Atomization

Fuel atomization is performed by the burner attached to the combustion chamber. This duple burner consists of the primary and main systems, and is controlled by the pressurizing valve of the flow control unit. The nozzle of the primary system is small and used for fuel injection at the time of low flow and low pressure as in the case of engine start, high altitude operation and relighting. When the fuel flow has increased, the large nozzle of the main system is used for fuel injection. (Refer to Para. 4.8.3.)

4.10.3 Fuel Pump

(1) Function of Fuel Pump

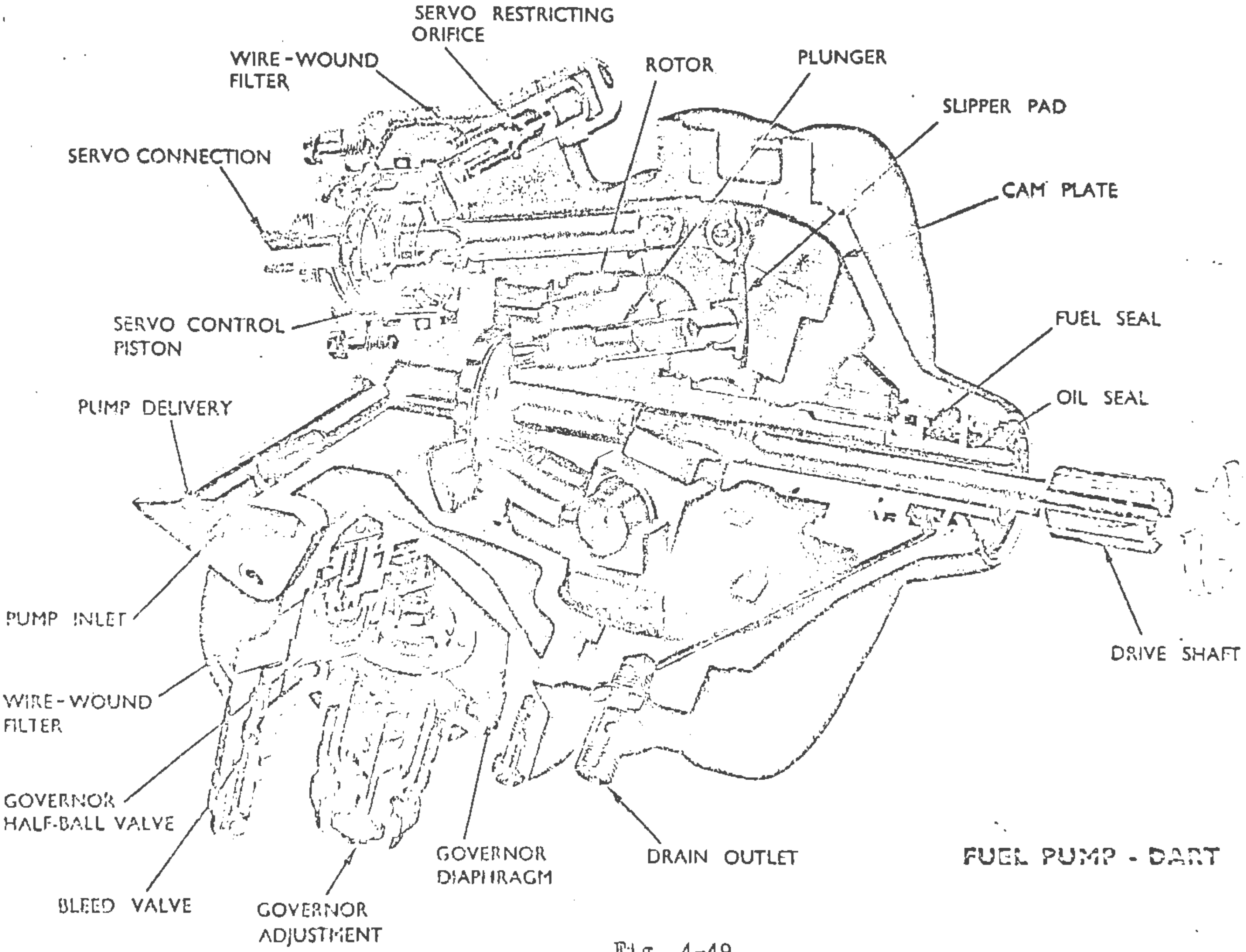
The low-pressure fuel from the fuel system of the fuselage passes through the fuel filter, entering the engine-driven fuel pump where it is pressurized.
The engine-driven H.P.pump has an engine-driven rotor fixed with seven spring-loaded plungers in contact with the circular cam plate. This cam plate can change its inclination as the rotor rotates.
By this inclination the fuel is pressurized and sent toward the fuel flow control unit. As the pump is directly coupled to the engine, the fuel flow can be changed also as the engine speed changes, however, it can be varied by the degree of inclination of this cam plate without changing the engine speed. The relation between the fuel flow and the engine speed at the time of maximum stroke is as shown in Fig. 4-45.

(2) Pump Servo Mechanism

In some speed range, the engine does not require such much fuel flow as in the case of maximum stroke. (Fig. 4-50) Accordingly the fuel pump is provided with servo mechanism for the individual control of fuel flow irrespective of the engine speed. The cam plate inclination is varied to change the fuel flow by the servo piston of this servo mechanism. This servo piston is controlled by pump output and pressure difference from the servo spill valve of the flow control unit. (Fig. 4-51)

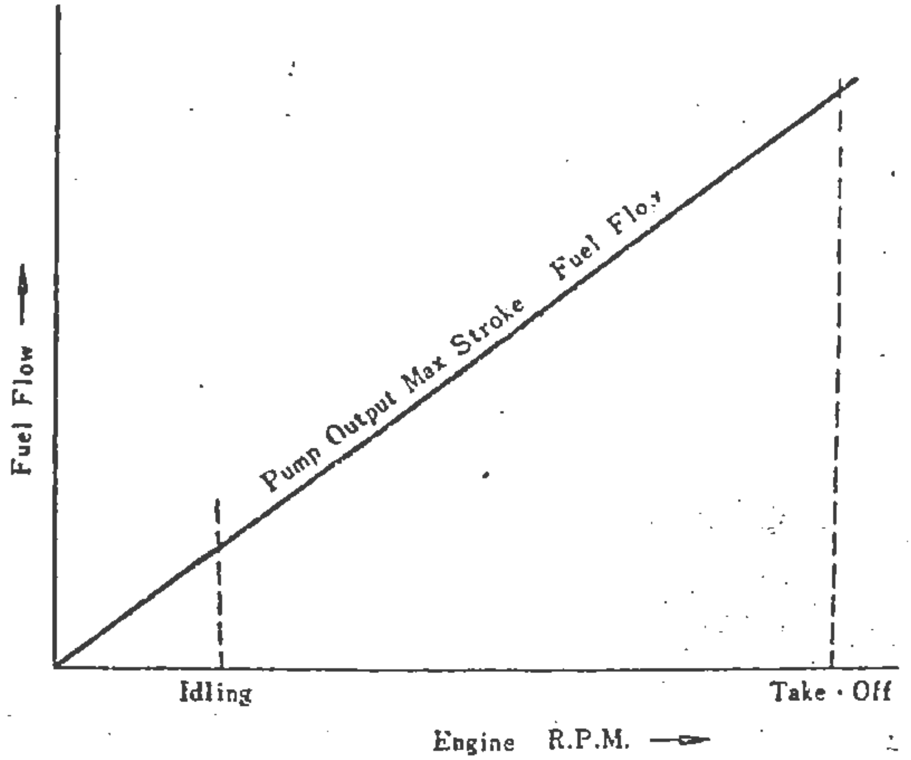
(3) Overspeed Control

The H.P. pump has an overspeed governor, which controls the fuel flow to govern the engine overspeed.
The governor is provided with a diaphragm which is designed to be controlled by the adjustable spring and pressure induced by the centrifugal force in the pump. Namely, in the event of engine overspeeding, the fuel pressure by the centrifugal force overcomes the spring tension to operate the diaphragm, spilling the fuel on the servo side of the servo piston to reduce the fuel flow to lower the engine speed.



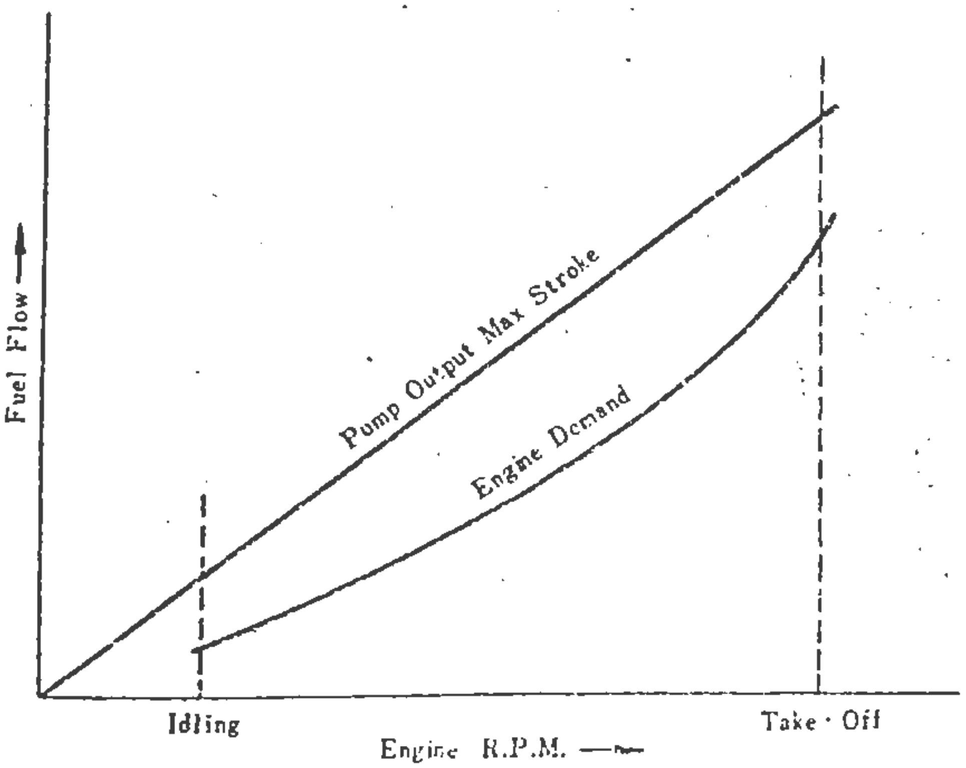
FUEL PUMP - DART

Fig. 4-49



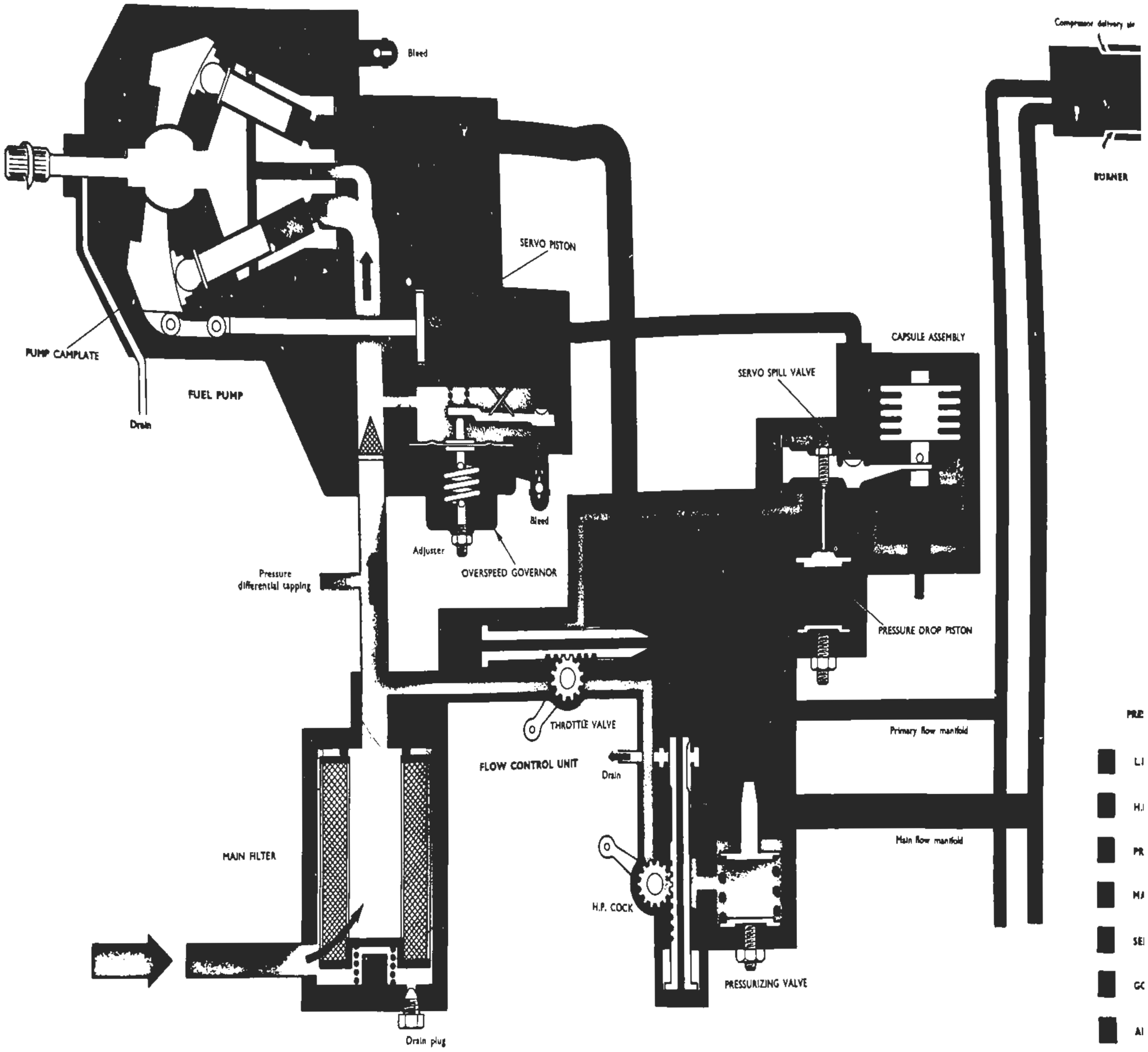
H.P. Fuel Pump Output

Fig 4 — 50



H.P. Fuel Pump Output & Engine Demand

Fig 4 — 51



Fuel system diagram
Fig. 4-52

)

For this purpose, the intake pressure capsules are designed so as not to increase the fuel flow even if the intake pressure exceeds 14.7 psi.

(5) Idling Control by Throttle Valve

The throttle valve is of such a make that, even in its fully closed position, it permits sufficient fuel flow necessary to maintain ground idling speed.
Idling speeds, however, are varied by various other factors.

Atmospheric condition.
Fuel trimmer position.
Propeller load.
Accessory gear box load.
Wind velocity.

(6) Engine Shut Down (H.P. Cock)

When stopping the engine, close the H.P. cock to cut off the fuel flow to the burner. When the H.P. cock is closed, the fuel in the manifold up to the burner is drained by the drain system.

(7) Pressurizing Valve

This valve is used to switch the fuel flow from the primary system to the main system of the burner or vice versa. At a low speed and low fuel flow, the fuel pressure is not enough to push down the valve spring and accordingly the fuel flows to the primary burner nozzle only. When both the engine speed and the fuel flow have increased, the fuel pressure exceeds a prescribed value, overcoming spring force. Thus the fuel flows also from the main burner nozzle.

4.10.5 Fuel Controlling

The fuel is controlled by the following procedure.

(1) Prior to Engine Start

When the engines are not running, the spring in the system has expanded fully. Accordingly,

Pump	Max. stroke
Governor spill valve	Close
Servo spill valve	Close
Pressurizing valve	Close
H.P. cock and throttles	Close

(2) Engine Start

When engine is started:

Engines start running.
Open the H.P. cock. (at 1,200 to 1,500 rpm)

Load on the spill valve lever decreases and the spill valve is moved toward CLOSE by the control piston assembly.
Accordingly the pump stroke becomes longer, increasing the fuel flow.
The increase of fuel flow passing through the throttle valve increases the differential pressure between both sides of the throttle valve; and the system is stabilized at a new fuel flow.

This state continues until the air intake pressure reaches 14.7 psi.

(6) Engine Shut Down

With the engines idling, close the H.P. cock to shut off fuel supply.
Thus combustion stops and engine speed drop results.
During a period from idling to stop, the output flow from the fuel pump returns through a hole in the H.P. cock in order to prevent fuel pressure increase. The burner manifold is connected to the drain side by a cut-away made in the H.P. cock.

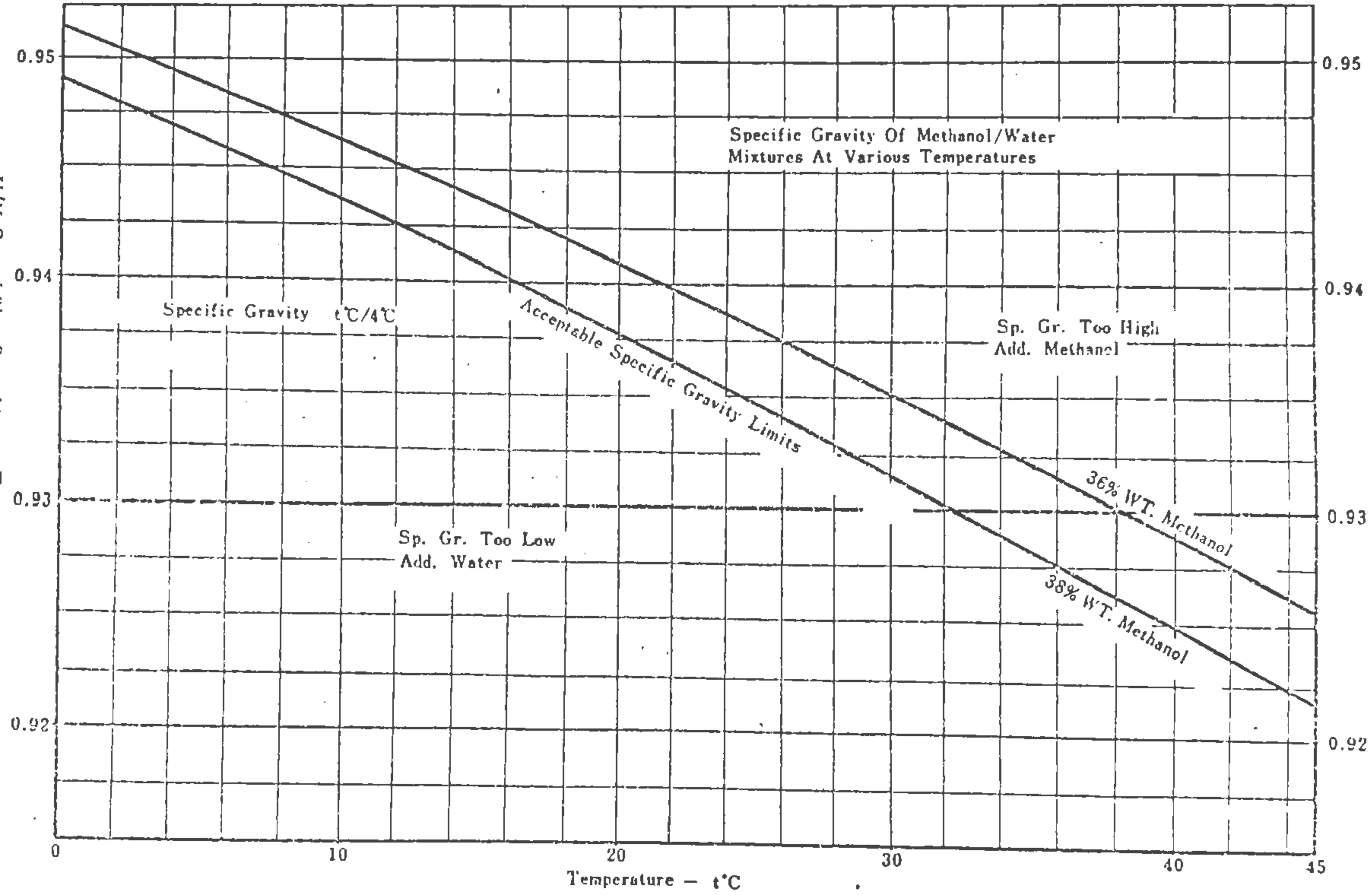
4.10.6 Fuel Heater

If water in the fuel is frozen, the L.P. fuel filter of the fuel flow control unit may be blocked, adversely affecting the engines. In order to prevent this defect, the fuel filter de-icing unit is employed. The fuel heater is located at the inlet of the L.P. fuel filter and utilizes hot air from the 2nd-stage compressor. The hot air flows through the hot air gate valve, reaching the heat exchanger in the fuel line before the filter.
Should icing have occurred, a difference of fuel pressures between the fore and aft of the filter is sensed by the differential pressure switch, and the warning light in the cockpit comes on. In the cockpit is the fuel heater switch. When the switch is turned "ON," the hot air gate valve is opened to send the hot air from the compressor to the heater. The heater switch has "AUTO" position, wherein the hot air gate valve is automatically opened by the differential pressure switch when the differential pressure exceeds 3 psi.
As the hot air is taken from the compressor by using the fuel heater, the engine power decrease slightly. The loss is about 4% of total power at the engine speed and T.G.T. at the time.

4.11 Water/Methanol System

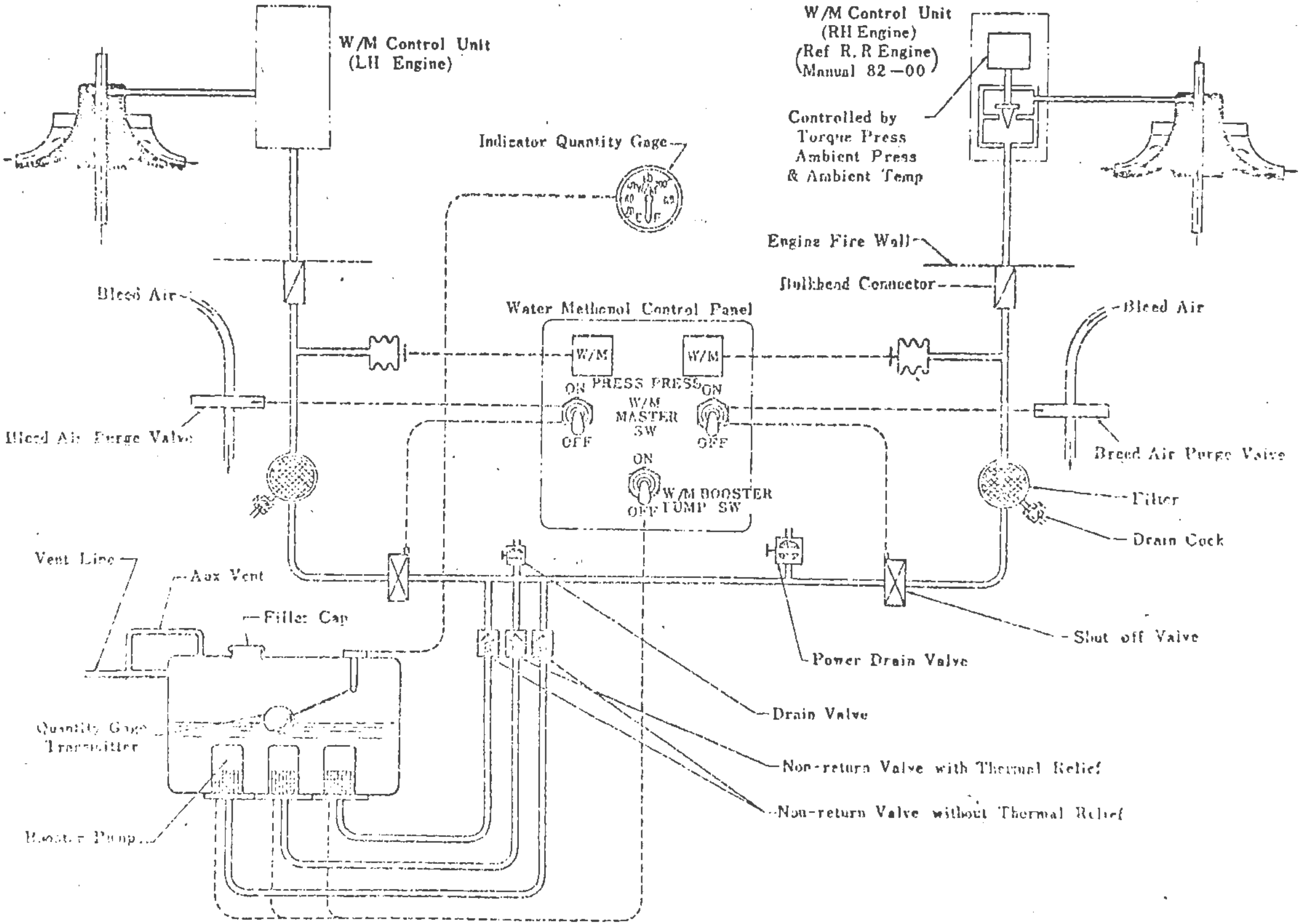
4.11.1 General

The duty of this system is to inject the water/methanol fluid, its flow being controlled by the water/methanol control unit, into the 1st-stage compressor of the engine, and also to measure the increment of engine power by utilizing the increase of mass flow by water/methanol evaporation and the effect of burning the methanol in the combustion system.
The mixing ratio of water to methanol is 63±1 percent to 37 ±1%.
In this engine (Dart 10-1), the use of water/methanol mixture serves not only to maintain the engine take-off power in the I.S.A. condition but also to boost up the power and maintain it at all air temperatures.
Namely, the water/methanol system is used to maintain the take-off power at the altitude of 10,000 feet or less and at the outside air temperatures from -20°C up to +30°C I.S.A.



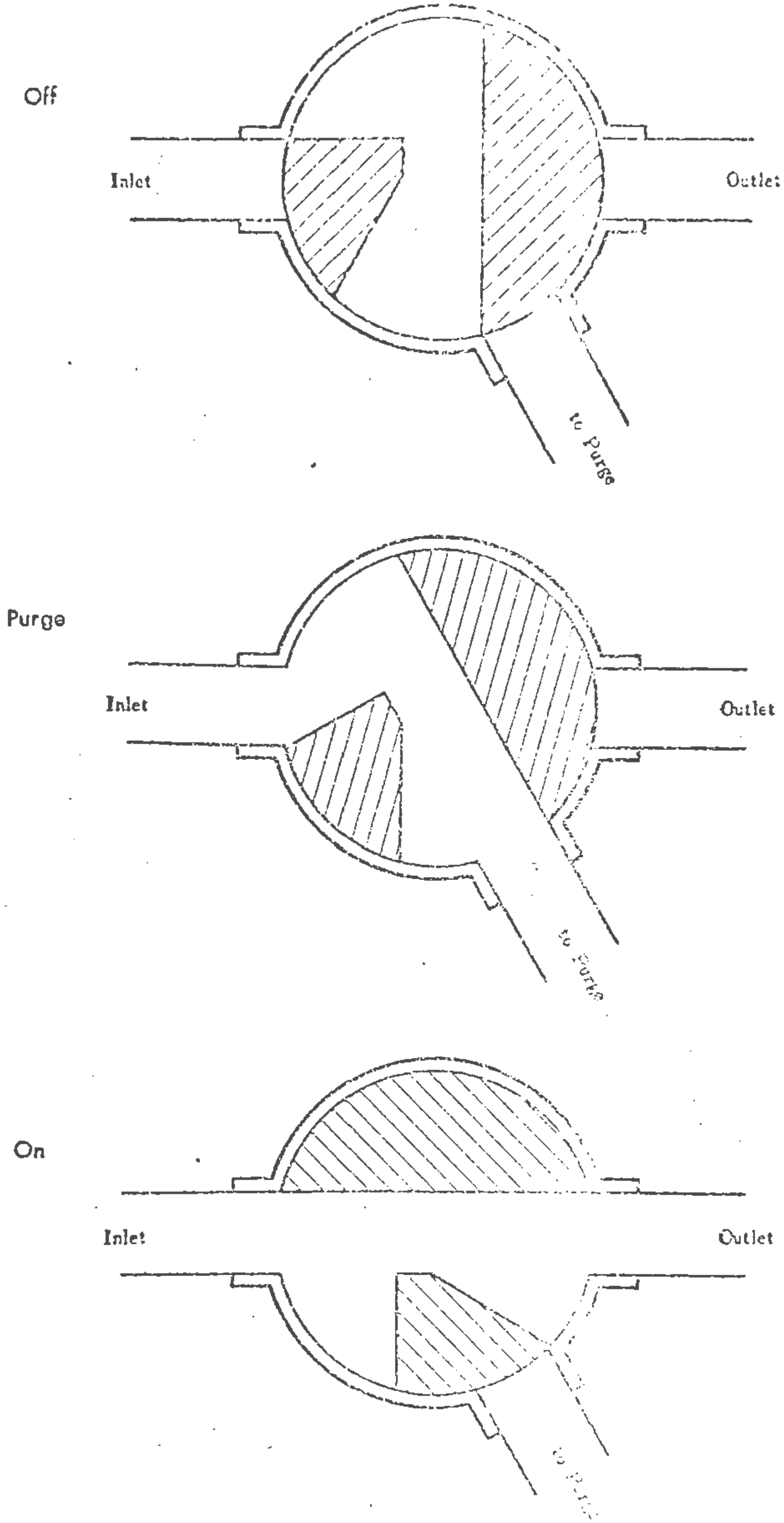
W/M Specific Gravity – Temperature

Fig 4 – 59



W/M System Control Diagram

FIG. 4-62



Purge Valve Position

Fig. 4-65

4.12 Starting System

4.12.1 General

To start the engine from the standstill condition,

- Drive the engine shaft by the starter motor, by operating the clutch and the ratchet engaging mechanism to make air flow.
- Supply the fuel by means of the fuel pump controlled by F.C.U., and seven burners.
- Energize Nos. 3 and 7 combustion chamber ignition plugs to start combustion by means of two high energy igniter units.

The above requirements are satisfied by the starting system; in addition, however, the following items must be taken into account.

- Engine start and ignition are automatically done simultaneously by the proper use of switches in the cockpit.
- It is possible to perform "BLOW-OUT," that is, just turn the engine only without combustion.
- For engine relighting in flight, ignition only takes place by means of the relight switch.

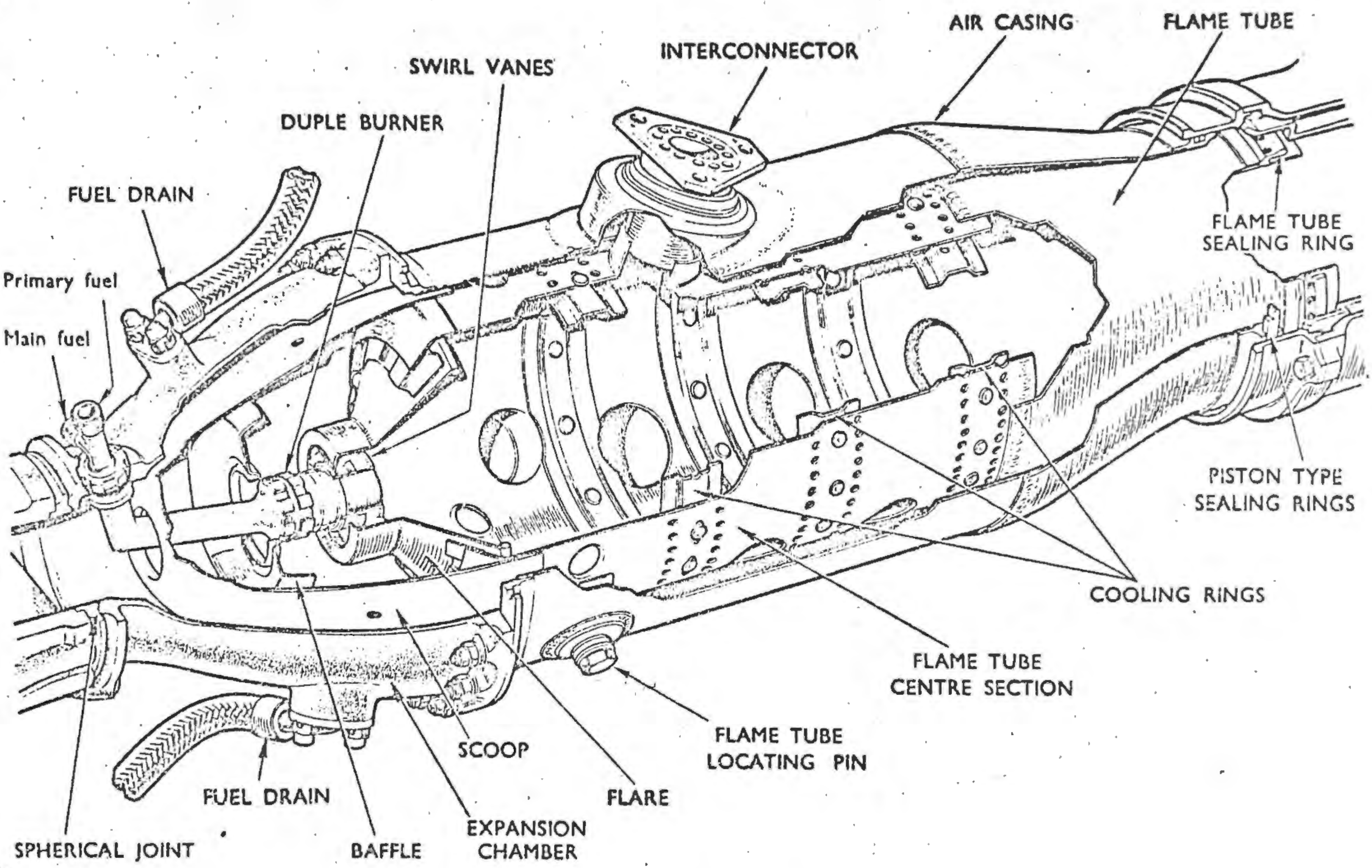
The starter system is provided with a circuit for preventing unnecessary starter motor revolution and the crash engagement of the starter motor engaging mechanism.

Engine start requires the electric current of about 2,000A at maximum; and accordingly both engines must be started by a ground power. As a feature of the starting system of YS-11, nickel-cadmium batteries are mounted as the internal power source on the aircraft. By these internal batteries, engine can be started. The electrical circuit of this starting system has its own bus; and therefore any fault, if any, in this system will never affect other systems. Particularly, since the starter motor employed is of a large capacity, there may take place few the possibility of false starts such as "hung start" is remote. In addition, the system has an anti-crash relay whereby engines can be protected from a damage caused by erratic engine start operation.

4.12.2 Starter Motor

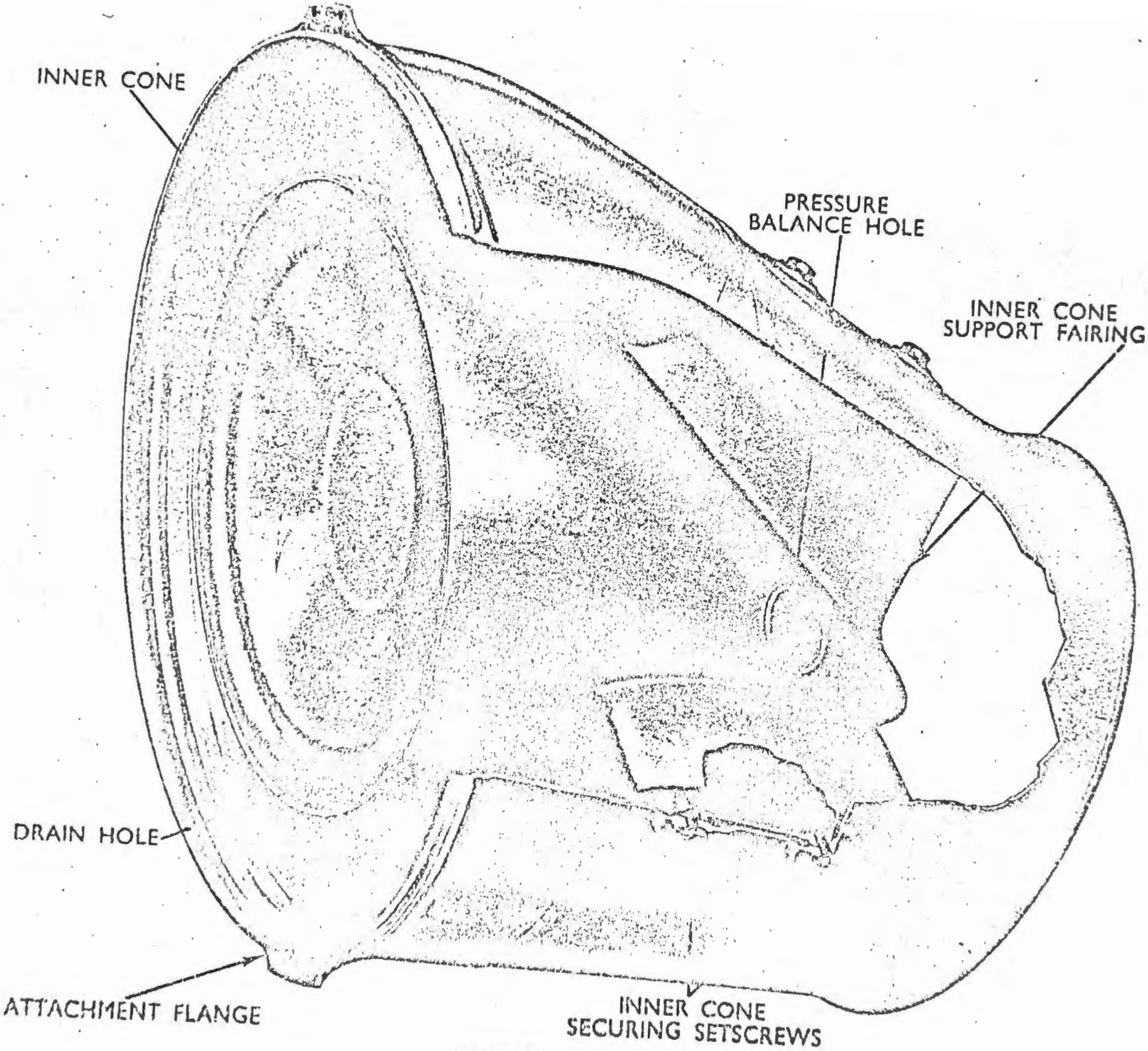
The starter motor is a 4-pole compound wound 28V motor having a capacity of about 17.5 BHP. This motor is attached on the right-hand side of the engine air intake casing. Since it has been so designed as to obtain starting speed quickly by such a small power, a longtime continuous operation should be avoided.

The starter motor power is transmitted to the engines through the multiple disc clutch assembly and the starter driven bevel gear. Six pawls are pushed by pawl springs against the bevel gear and the drive power is transmitted to the high-speed pinion through these pawls.



COMBUSTION CHAMBER

Fig. 4-34



EXHAUST UNIT Fig. 4-41

The overspeed governor functions also as a relief valve to prevent the excessive increase of system fuel pressure. The spill valve rocker arm of the overspeed governor is pushed by a spring; and accordingly when the fuel pressure supplied by the pump has increased excessively, lower it to the predetermined maximum value (stall pressure) and open the spill valve to actuate the servo piston to reduce the pump stroke.

4.10.4 Fuel Flow Control Unit (F.C.U.)

(1) Pressure Drop Control Piston and Throttle

The spill valve inside the fuel flow control unit operates in accordance with throttle movement, changing the quantity of fuel to be supplied by the pump.
This spill valve serves to maintain fuel flow in proportion to the throttle position by means of the pressure drop control piston which is moved by the fuel pressure on both sides of the throttle valve. When the fuel flow is kept steady without moving the throttle lever, a difference in fuel pressure between both sides of the control piston is balanced against the spring force, automatically controlling the pump servo piston to obtain an adequate pump stroke, i.e., proper fuel flow.

(2) Fuel Datum (Fuel trimmer)

Fuel trimmer also functions to select a new fuel flow by changing the throttle valve position in the fuel flow control unit. The operation of this device is as described earlier. That is, the throttle valve is operated either by the throttle lever or by the fuel trimmer.

(3) Intake Pressure Capsule or Intake Air

As the altitude increases, the quantity of fuel required by the engines decreases even if the throttle position remains the same. Accordingly the servo spill valve of the fuel flow control unit senses the variation of altitude by means of the capsule assembly designed to be changed by the engine air intake pressure, and starts to operate.
The capsule assembly consists of vacuum and intake air pressure sensing capsules. (Fig. 4-52) When the altitude has increased and the air intake pressure has dropped, the capsules are unbalanced, moving the spill valve lever. By this operation the control piston spring is compressed and the fuel pressure necessary for opening the spill valve decreases.
Thus, the spill valve is opened wider and the pump stroke decreases. The throttle valve pressure drop also decreases to the point where the control piston is balanced. The fuel flow is stabilized at the value proportional to air flow decrease resulted from intake pressure decrease (increase of altitude) as stated above.

(4) Power Limitation

Contrery to (3), as intake air pressure increases, the fuel flow also increases. However, engine power must be limited below I.S.A. sea level condition so that its rating will never be exceeded.

Engines are ignited; and as engine speed increases, the fuel flow also increases.
The control piston senses pressure difference between both sides of the throttle valve.
With the pressurizing valve kept closed, the fuel is ejected from the primary nozzle only.

With a further increase in both pump speed and fuel flow:

The pressure difference on both sides of the throttle valve approaches a fixed value.
When the pressure difference exceeds the fixed value, the control piston is moved by the pressure on the pump output side and the servo spill valve is opened, moving the servo piston to decrease pump stroke. Thus, the fuel flow comes to be stabilized at a point where the differential pressure between both sides of the throttle valve is kept constant.

(3) Acceleration

In Fig. 4-54,
When the throttle lever is moved from (A) position toward OPEN, the differential pressure between both sides of the throttle valve drops and the control piston is moved to close the servo valve. Thus, both pump stroke and fuel flow increase, reaching (B) position. In this position, the differential pressure of the throttle valve increase of the fuel flow; thus the engine speed, i.e., the pump speed increases resulting in a further increase of the differential pressure up to (C) position, where the pressre difference is stabilized at a fixed value. Thereafter, pump stroke gradually decreases and the fuel flow is stabilized at a point corresponding to the selected throttle position, the speeds reaching the desired value. (D)

Actually, however, as propellers are provided, the procedure is not as described above but follows the sequence of (A)-(E)-(D) by smooth throttle operation.

(4) Climb to Altitude

As the aircraft climbs, the air intake pressure decreases, and the evacuated capsule inside the intake pressure capsule expands to open the spill valve.
The pump servo piston moves to decrease pump stroke and accordingly the pump fuel decreases to reduce fuel flow.
When the fuel flow passing through the throttle valve decreases, the differential pressure also decreases.
When capsule movement has changed the spring load of the control piston and consequently decreased the pressure difference, the system is stabilized at a new differential pressure (lower than before). Namely, obtained is a fuel flow proportional to the air intake pressure.

(5) Airspeed Increase

When the airspeed is increased in the same atmospheric condition, ram pressure increases, resulting in the expanded air intake capsule.

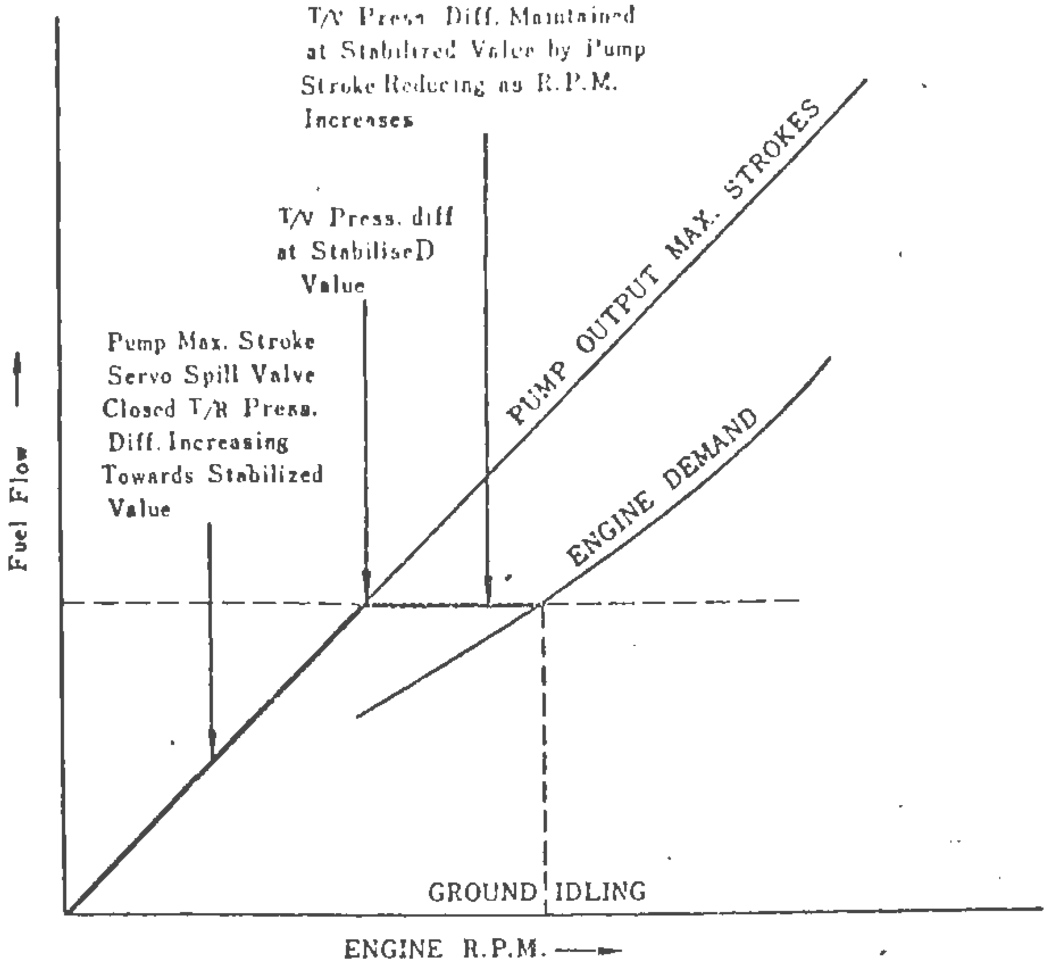


Fig 4 — 53

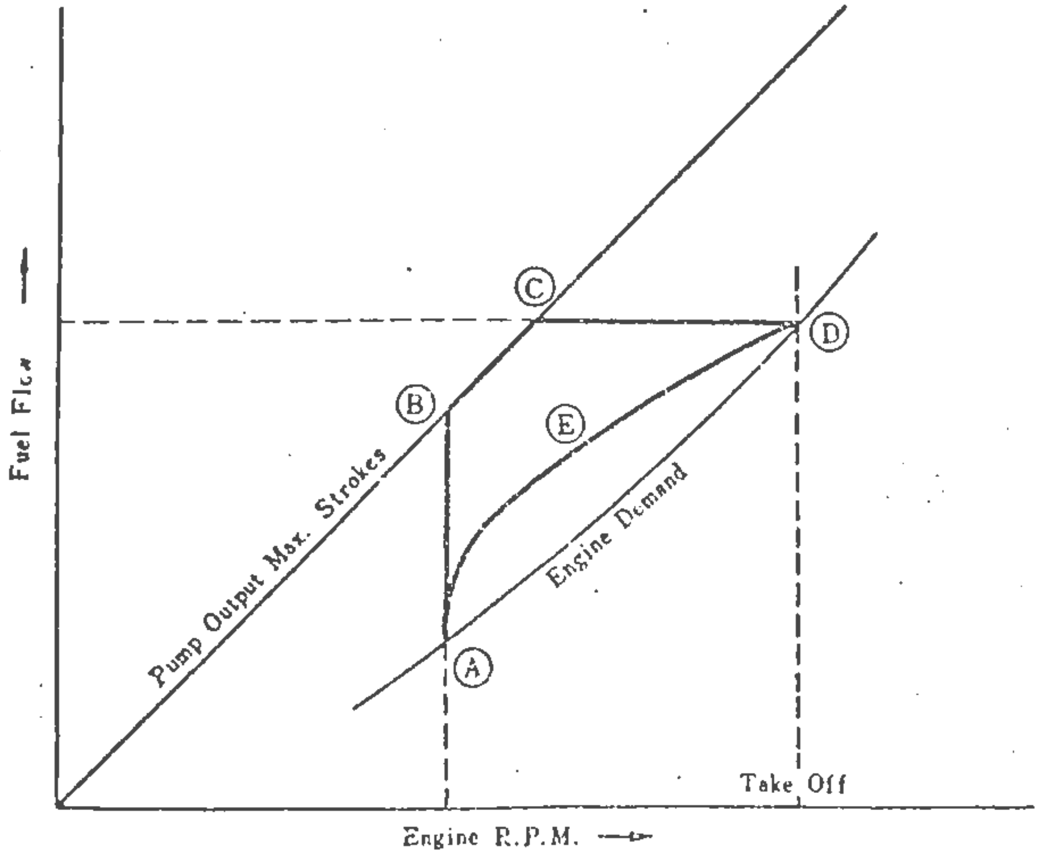
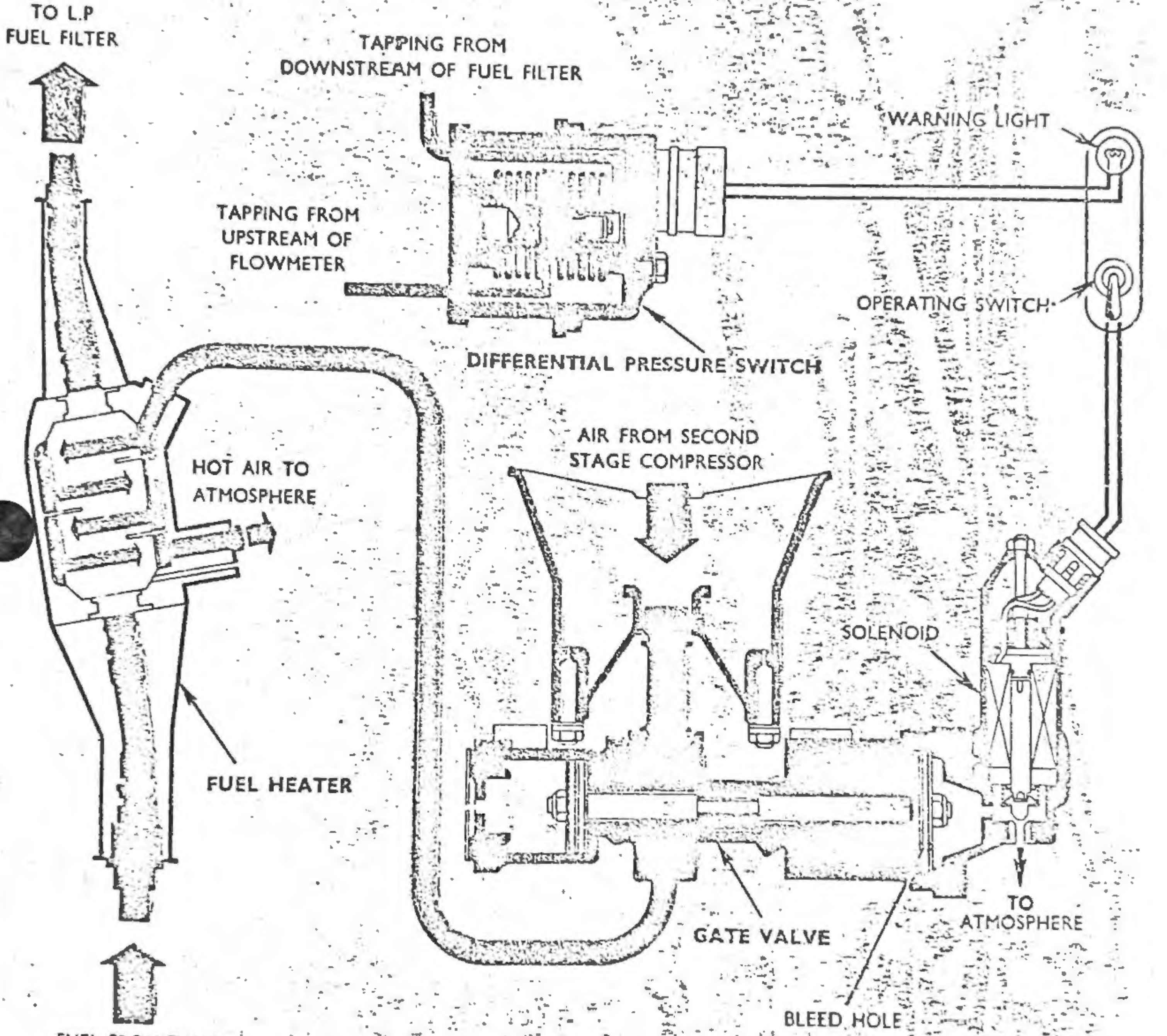
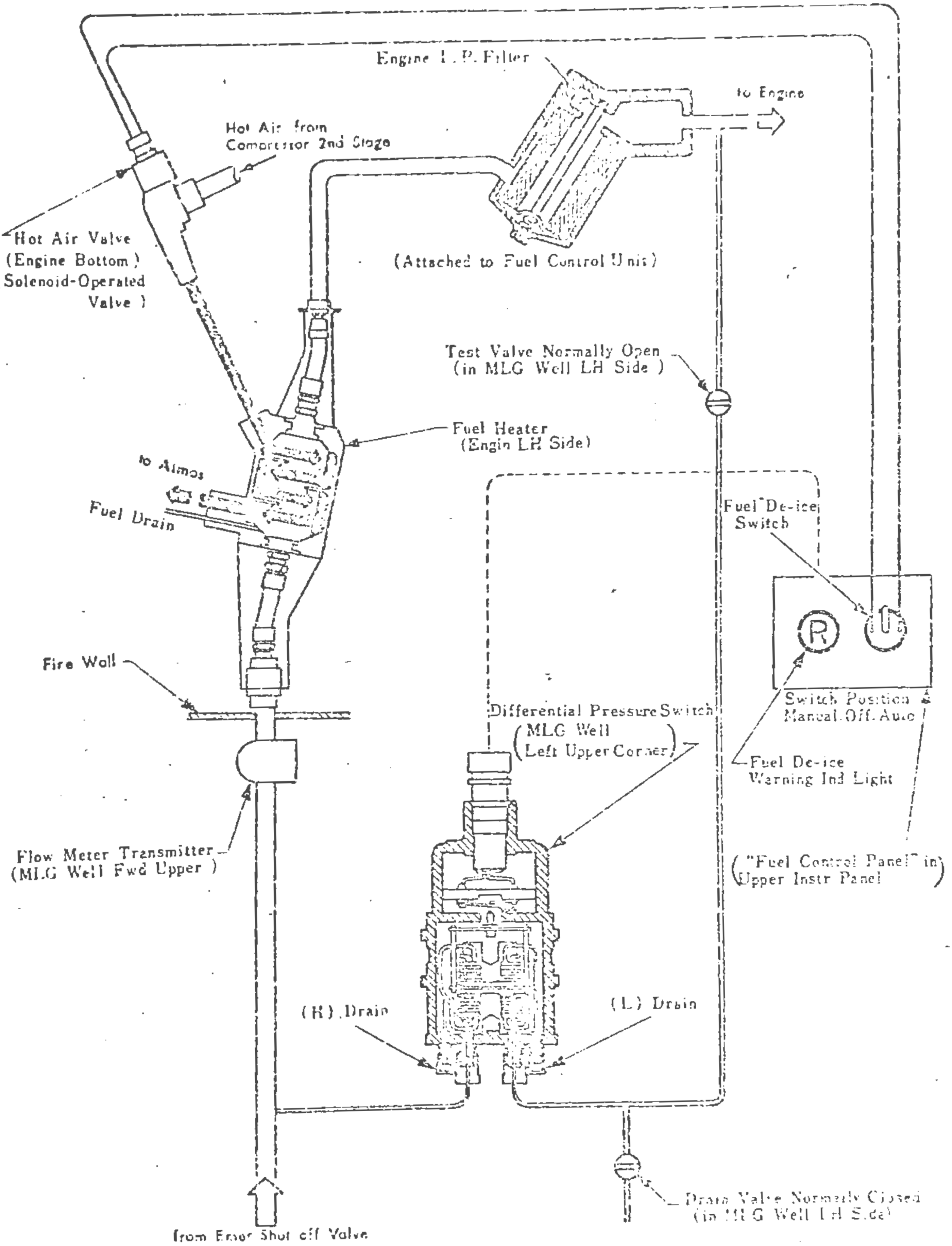


Fig 4 — 54



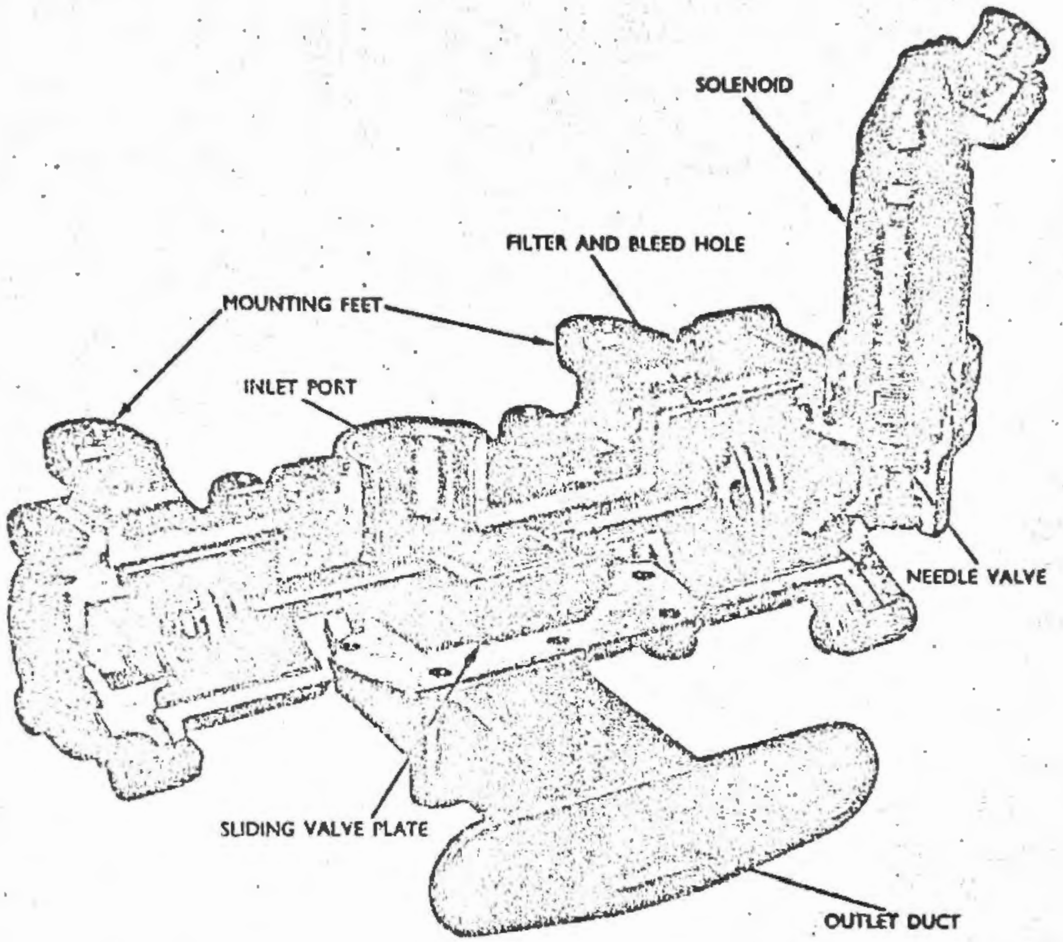
OPERATION OF FUEL FILTER DE-ICING SYSTEM

Fig. 4-56



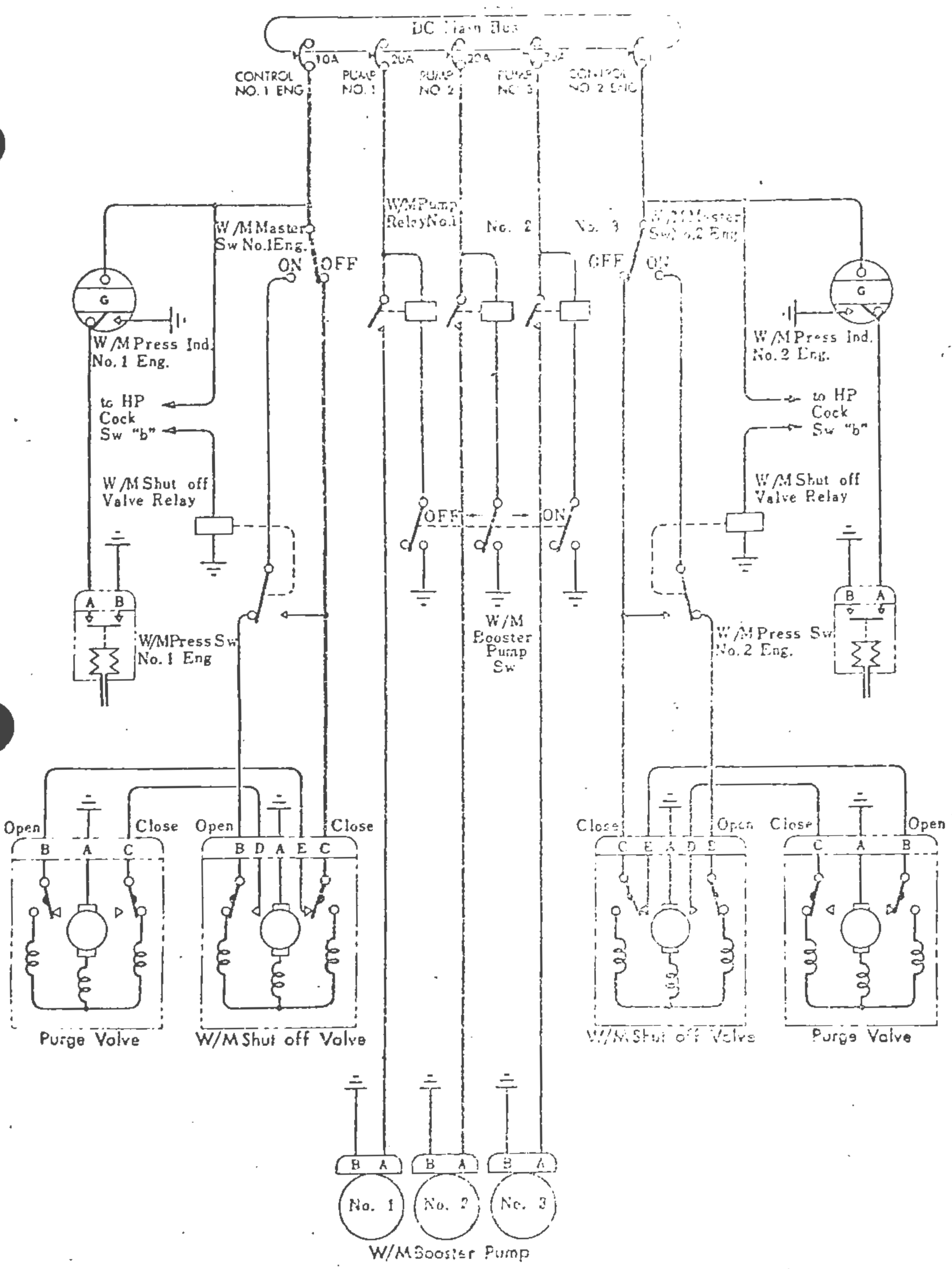
Fuel Heating (Engine Filter De-icing) and Warning Control Schematic

Fig. 4-57



HOT AIR VALVE

Fig. 4-58



W/M Theoretical Diagram

Fig. 4-63

To operate the water/methanol system, turn both the boost pump switch and the shut-off switch of the water/methanol feed system "ON," and the water/methanol control unit controls and injects the proper quantity of water/methanol mixture automatically when prescribed requirements are met.

4.11.2 W/M Feed System

W/M Tank

The synthetic rubber bladder type tank is installed between the spars of the left-hand main wing, near the fuselage. Its maximum capacity is 110 U.S. gallons. The quantity of the water/methanol mixture in the tank is indicated by the W/M quantity indicator in the cockpit.

W/M Booster Pump

Inside the water/methanol tank are always immersed the three centrifugal pumps. These pumps are designed to be operated by means of one pump switch from the cockpit.

Shut-off Valve

Both the right and left shut-off valves are motor-driven valves, which are so designed as to be operated separately by means of the water/methanol master switch. The duty of this valve is to control the flow of water/methanol mixture from the booster pump into the water/methanol control unit. However, the shut-off valve is provided to operate only when the water/methanol switch is "ON" and the fuel H.P. cock lever is in "FUEL ON" position. For the purpose of indicating that the shut-off valve is open and the proper quantity of water/methanol mixture is being forced invariably into the water/methanol control unit, the indicator light is provided.

4.11.3 W/M Control Unit

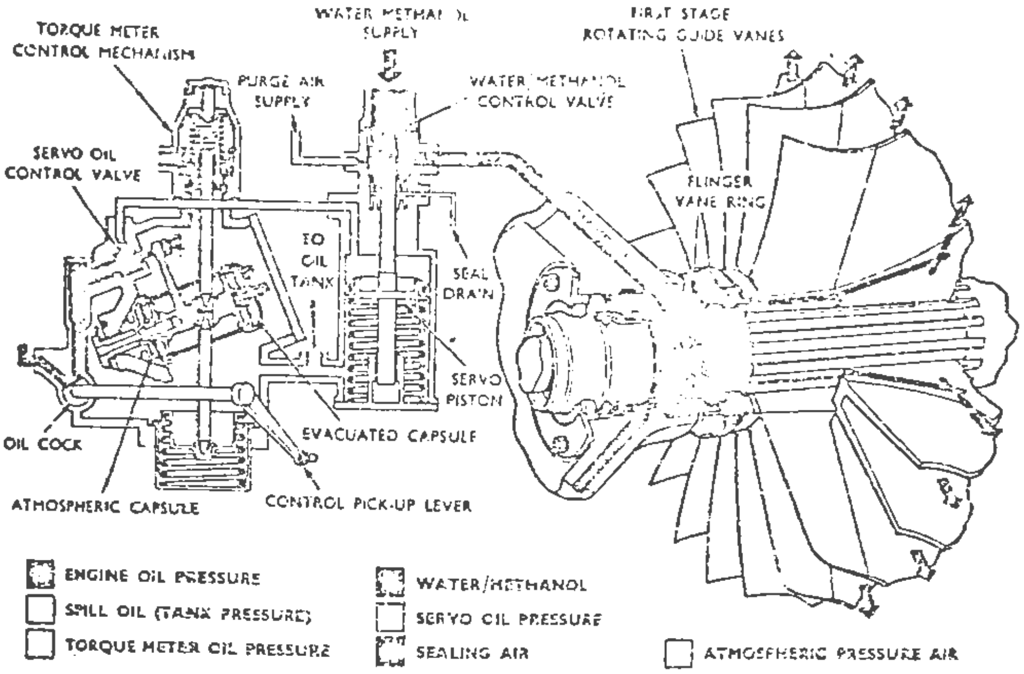
The water/methanol control unit sends W/M to engine, controlling a valve which is operated by servo system utilizing engine oil as a method of operation. The servo system pressure, i.e., the valve opening is controlled by both the engine power from the torquemeter system and the control system which senses the outside air temperature and altitude by the capsule assembly. The water/methanol unit is connected to the throttle lever and so designed as to supply the water/methanol mixture only when the engine speed has exceeded about 14,800 rpm. (Fig. 4-64)

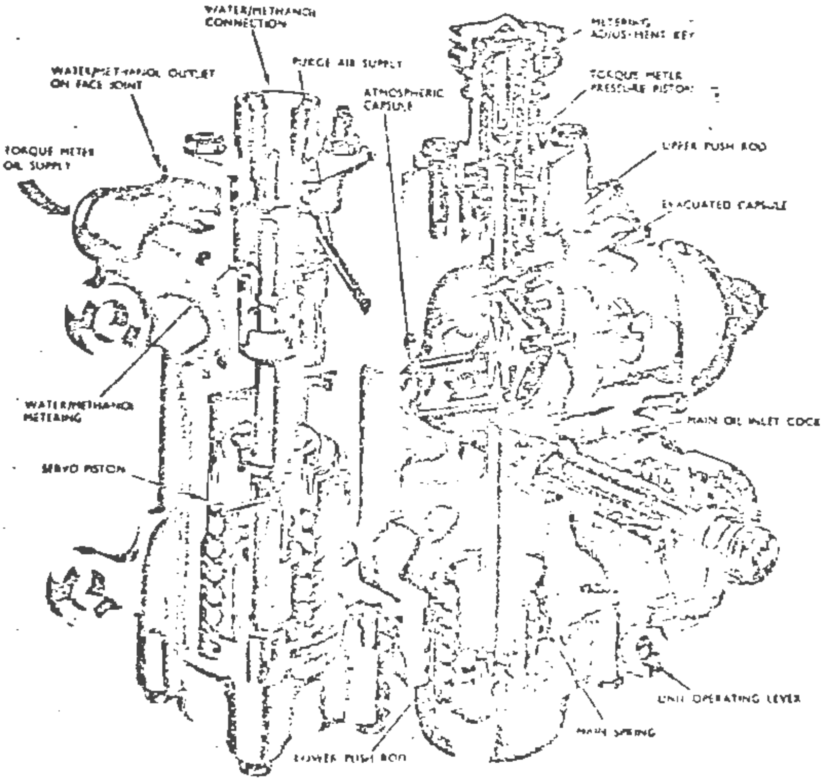
The water/methanol mixture coming out from the water/methanol control unit is centrifugally delivered into the compressor from the rotating guide vanes of the first-stage compressor.

4.11.4 Operation

Prior to take-off, turn "ON" both the water/methanol booster pump switch and the water/methanol master switch. If the system is normal and the water/methanol mixture is pressurized, the indicator light comes on. Water/methanol is so prepared as to be usable at any time.

Move the throttle lever up to 14,800 rpm or higher, and the oil cock inside the unit is automatically opened, the high-pressure engine oil reaching the servo control valve.





WATER/METHANOL SYSTEM

& CONTROL UNIT - DART

Fig. 4-64

The servo valve opens to permit the flow of the engine oil, which then overcomes the spring force to push down the servo piston, opening the water/methanol metering valve connected to this piston. The oil coming through the servo control valve to the servo cylinder serves to prevent the occurrence of hunting by restriction. The servo control valve controls the engine oil pressure in accordance with a force acting on the capsule assembly. The torquemeter pressure is transmitted to the capsule stem through the piston and the push-rod, moving the servo valve toward "CLOSE." Spring load corresponding to this pressure also works to open the servo valve through the push-rod. The pressure and spring load are balanced when the engine torque pressure has reached the selected value.

The capsule assembly consists of two capsules: one contains vacuum inside while the other takes in the atmospheric pressure. These capsules work to close the servo control valve when the atmospheric pressure has decreased, so that T/O power will be calibrated to a value by altitude. The engine wet power decreases as the altitude increases.

To cut off the supply of water/methanol mixture after take-off, move the throttle lever to a speed less than 14,800 rpm., and the water/methanol supply is automatically shut off. The injection of water/methanol mixture can be cut off also by turning off the water/methanol master switch, which, however, is allowed to be used strictly in an emergency because it may have a bad influence on the engines. Also from the same reason, the use of the water/methanol mixture must be determined at the engine speed over 14,500 rpm and the master switch must not be turned on.

.11.5 Engine Bleed Air Purge Valve

The engine bleed air is taken from the 2nd-stage compressor outlet. This bleed air is used for various purposes such as: sup-power for pressure control of the air-conditioning system, for the reservoir of the hydraulic system, and for cooling the DC generator. Accordingly if the water/methanol mixture is supplied, the air containing water/methanol is supplied as the bleed air to these equipment, resulting in corrosion. Consequently when water/methanol injection is done, the bleed air should be shut off; and even after injection, water/methanol remaining in the pipe must be discharged outboard and only the clean air is delivered to these equipment through the bleed air line. For this purpose, the purge valve is installed in the bleed air line.

This purge valve is so designed as to be operated by the water/methanol master switch in connection with the shut-off valve. (Fig. 4-65)

When the master/methanol switch is turned "ON,"

Shut-off valve opens, and then
Purge valve is closed.

When the water/methanol switch is turned "OFF,"

Shut-off valve is closed, and then
Purge valve is opened.

When the purge valve is opened, the valve is open to the purge side; and therefore the bleed air in the air line from the compressor outlet to the purge valve is let out into the air. When it has been fully opened, the bleed air is clean.

EXTERNAL POWER STARTS - YS-11A

External Power Starts on the YS-11A require more power than our external power units can put out. The following procedure will aid in getting a better start and will not require the use of 2000 ampere units.

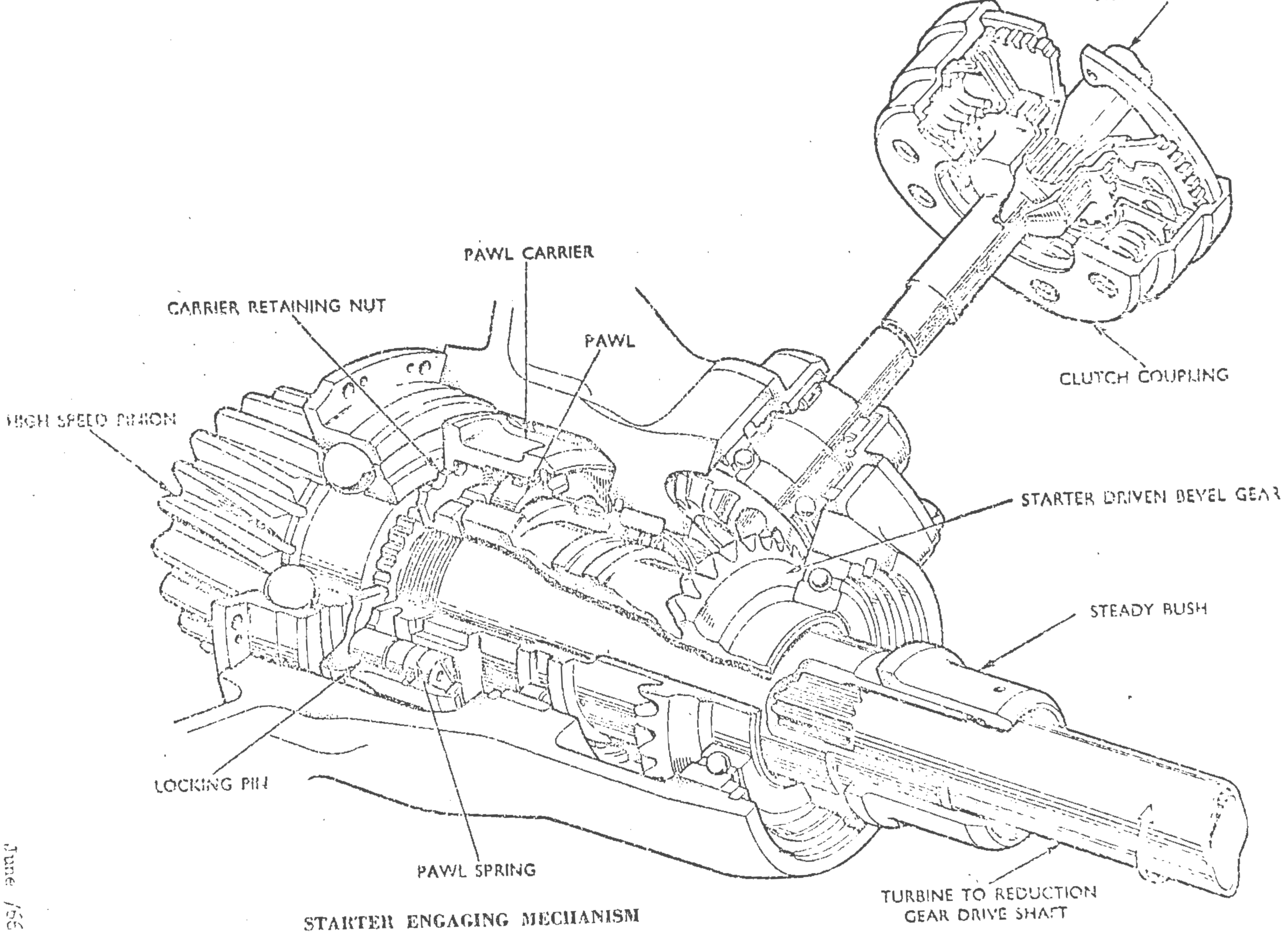
If the external power unit is 1000 amps or above (yellow flag)

1. Plug in external power and check that external power unit voltage is proper 28.5 volts ± .5 volt.
2. Place the battery switch on the overhead panel to "Battery" position.
3. Place the Engine Select switch to the OFF position.
4. Place the starter master switch to start.
5. The batteries are now being charged from external power.
6. When you are ready to start engines place the engine select switch to the desired engine and push the start switch. The batteries and external power will start the engine.

If the external power unit is less than 1000 amps (Red flag)

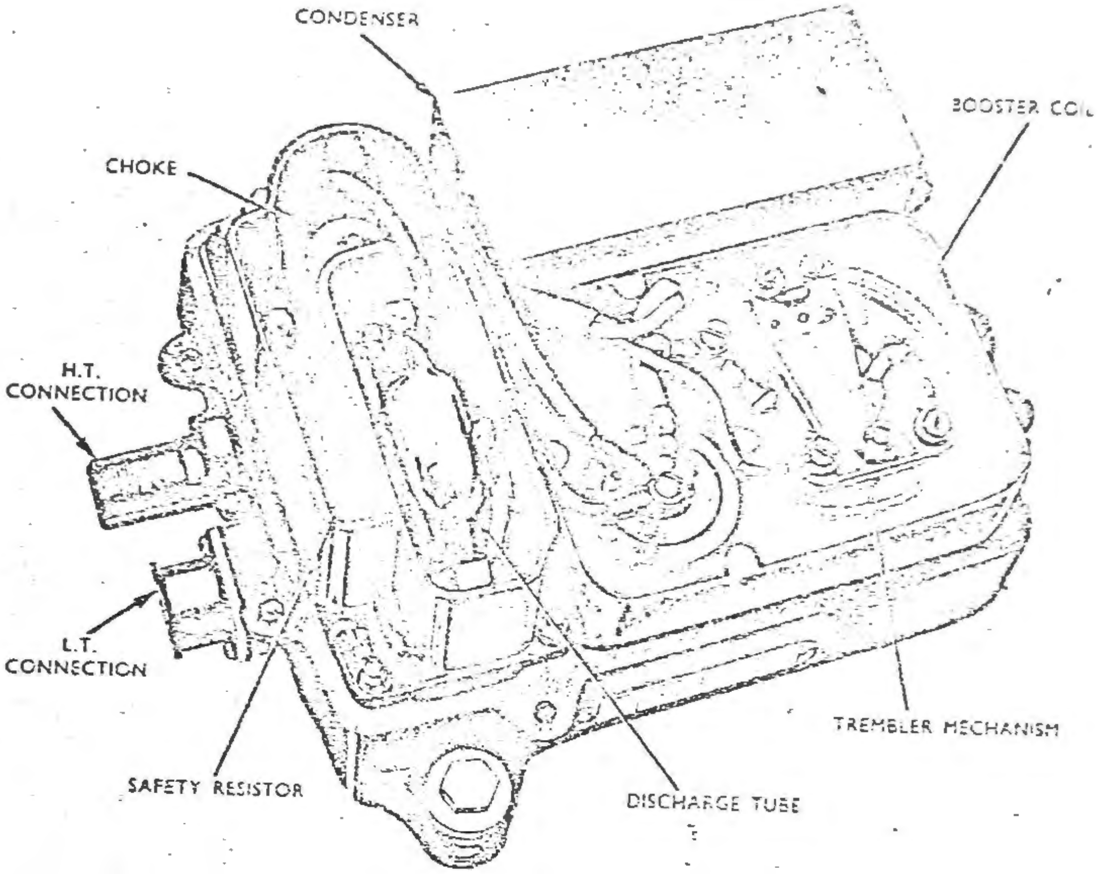
1. Plug in external power and check that external power unit voltage is proper 28.5 volts ± .5 volt.
2. Place the battery switch on the overhead panel to "Battery" position.
3. Place the Engine Select switch to the OFF position.
4. Place the starter master switch to start.
5. The batteries are now being charged from external power.
6. When you are ready to start the engines place the starter master switch to SAFE and have external power disconnected and removed.
7. Proceed with the normal battery start.

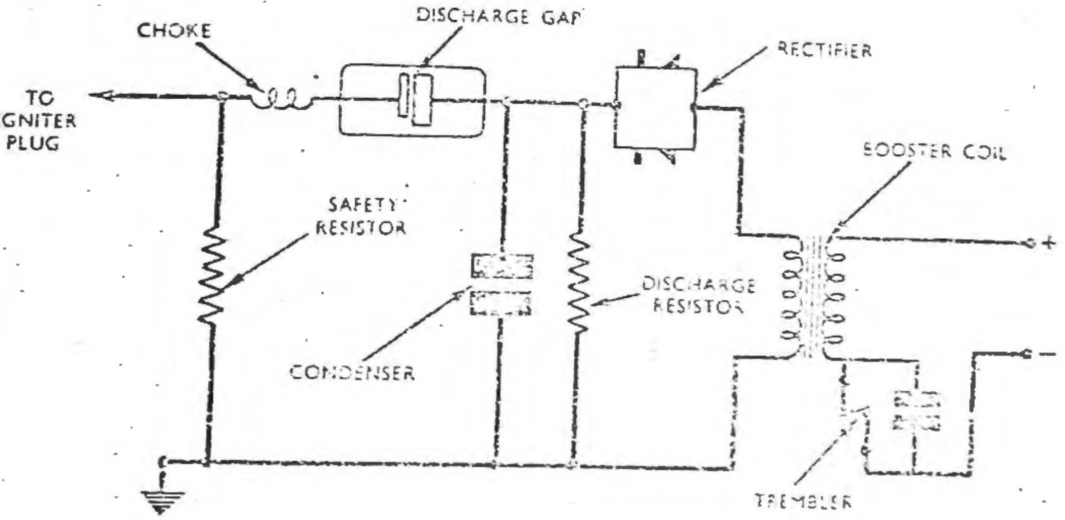
Inverters can be left on during battery charging if desired. Inverters should be OFF when making a battery start.



STARTER ENGAGING MECHANISM

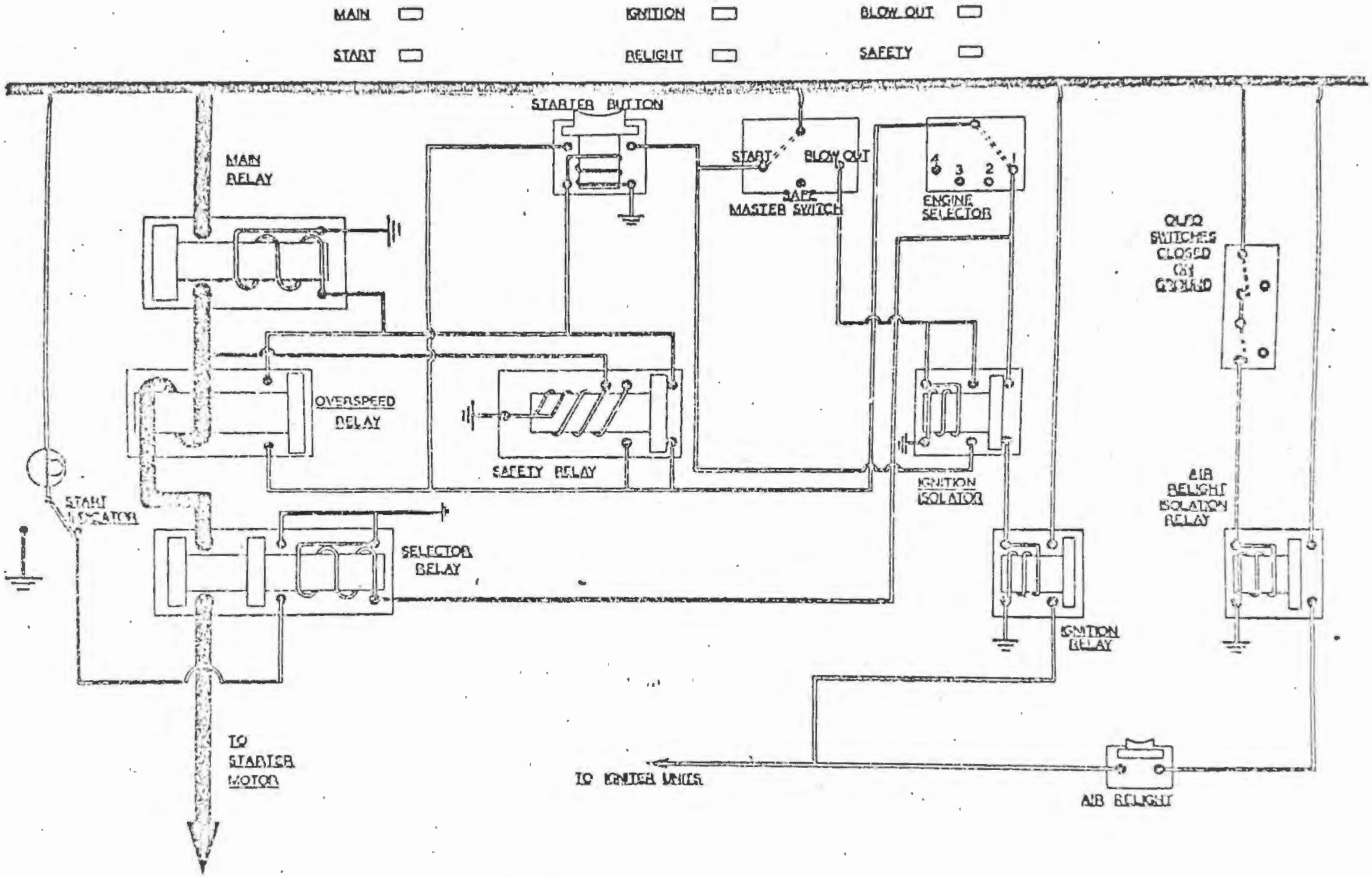
Fig. 4-66





IGNITION UNIT

Fig. 4-67



TYPICAL STARTER CIRCUIT

Fig. 4-68

When the engines have reached their self-sustaining speed, the pawls are disengaged by virtue of centrifugal force. The speed ratio of the starter motor to the engine shaft is 2 to 1. (Fig. 4-66)

4.12.3 High Energy Ignition Unit

On the right-hand shear panel of the engine are fitted two high energy ignition units, which supply a high-tension electric energy to the igniter plugs of Nos. 3 and 7 combustion chambers. The discharging frequency of these ignition units is comparatively small, about 60 times per minute; but a tremendously great energy is discharged.

4.12.4 Construction of Starter System

The starter system is operated remotely from the cockpit by means of the following switches.

Starter button
Master switch
Engine selector switch
Air relight switches (two)

Starter Button:

The starter button is so designed that, once depressed, it is automatically held "ON" by means of the hold-in coil; and when engine start has been completed, it automatically turns "OFF" to interrupt the circuit. This button is used for engine start and blow-out operation.

Master Switch:

The master switch has three positions: SAFE, START, and BLOW-OUT.

- In "SAFE" position, the starter circuit is OFF; and accordingly the starter will not start even if the starter button is depressed.
- In "START" position, the starter motor and the ignition circuit are energized simultaneously if the starter button is depressed, starting engine.
- In "BLOW-OUT" position, the starter motor only is operated if the starter button is depressed.

Engine Selector Switch:

This switch is used for selecting an engine for start. With this switch in "OFF" position, the starter motor will not run if other switches are turned "ON."
To run the engines, these three switches must be operated.

Air Relight Switch:

To restart the engines in the air, the starter motor must be used. In this case, the ignition system of the starter circuit can not be used; and accordingly air relight switches are provided one for each engine, so that the ignition system may be used irrespective of the starter system. This air relight switch is also usable for other purposes.
Beside the cockpit switches, the automatic control system incorporating relays are used for the operation of the starter system.

Overspeed Relay:

The purpose of this overspeed relay is to prevent the starter motor from running when not required after completion of engine start. The relay senses the electric current flowing to the starter motor and, when engines have reached their self-sustaining speed and the current has decreased to less than 150A, the starter circuit is opened.
The relay operates at the engine speed of about 4,500 rpm.

Safety Relay (Anti-crash Relay):

The duty of this safety relay is to prevent the occurrence of a trouble with the starter energizing mechanism.
This relay is provided to break the starting circuit even if the starter button is kept depressed when the overspeed relay is actuated due to an increase in engine speed.

4.12.5 Starter Control Timer

At the beginning of engine start, a tremendously great power flows into the starter. In order to restrict this current for the purpose of limiting the length of starter operating time, the starter control timer is provided. The timer consists of a motor, two microswitches, clutch and spring.

Contact A: Operates 6±0.5 seconds after engine start to actuate the starter resistor relay, releasing the resistor which limits the initial great current.

Contact B: Operates 30^{+3}_{-0} seconds after engine start, interrupting the holding circuit of the starter button.

Thanks to this starter control timer, the starter button is automatically released 30 seconds after engine start, interrupting the starter circuit. Also, when the engine speed exceeds about 4,500 rpm., the overspeed relay works automatically to break the starter circuit. Accordingly provided the starter button is not released after 30 seconds of engine start or when the engine speed has exceeded 4,500 rpm., manually release the starter button or open the starter circuit after turning off both the master switch and selector.

4.12.6 Starter System Operation

When starting the engines, make sure of the following items.

Engine oil temperature: External power supply over -30°C
Internal power supply over -10°C

Voltage: External power supply 28V
Internal power supply 24V

As for the aircraft, the following should be observed.

Propellers: Ground fine pitch (0°)
Propellers are not rotating.
Propeller brake switch is OFF.

4.13 Power Control Unit

4.13.1 General

The power control unit consists of the following three systems.

Throttle control system
Fuel trim control system
H.P. cock control system

On the cockpit pedestal are arranged throttle lever, H.P. cock lever and fuel trim switch, whereby the above three systems are operated. These levers and switch are mutually interconnected and also have connection with both the low stop lever and gust lock lever.

4.13.2 Throttle Control

Fuel flow control and rpm control are performed by means of a single throttle lever which is mechanically interconnected with the control systems concerned. Water/methanol injection also can be controlled by means of this throttle lever. The principle of its mechanism is shown in Fig. 4-71.

4.13.3 Fuel Trim Control

For the purpose of decreasing the fuel flow in accordance with air temperature rise, the fuel trimmer is provided, which changes the fuel flow only, without varying the engine speed, by restricting the throttle valve opening of the fuel flow control unit.

4.13.4 H.P. Cock Control

The H.P. cock control is used to control the high-pressure fuel flow inside the fuel flow control unit. This is connected to the propeller control unit and used also as a propeller feathering selector and a propeller high stop withdrawal (Lock Out) selector.
For this purpose, the H.P.C. lever at the pedestal has the following four positions.

LOCK-OUT (HIGH STOP WITHDRAWAL)
FUEL ON
FUEL OFF
FEATHER

In LOCK-OUT position, the F.C.U. cock remains in FUEL ON position and, in FEATHER position, remains in FUEL OFF.

4.13.5 Relation among Gust Lock and Low Stop and Throttles

In order to lock the control surfaces of the aircraft, the gust lock lever is provided in the cockpit. This lever is mechanically connected to throttle levers and low stop lever to avoid take-off with the gust lock applied.

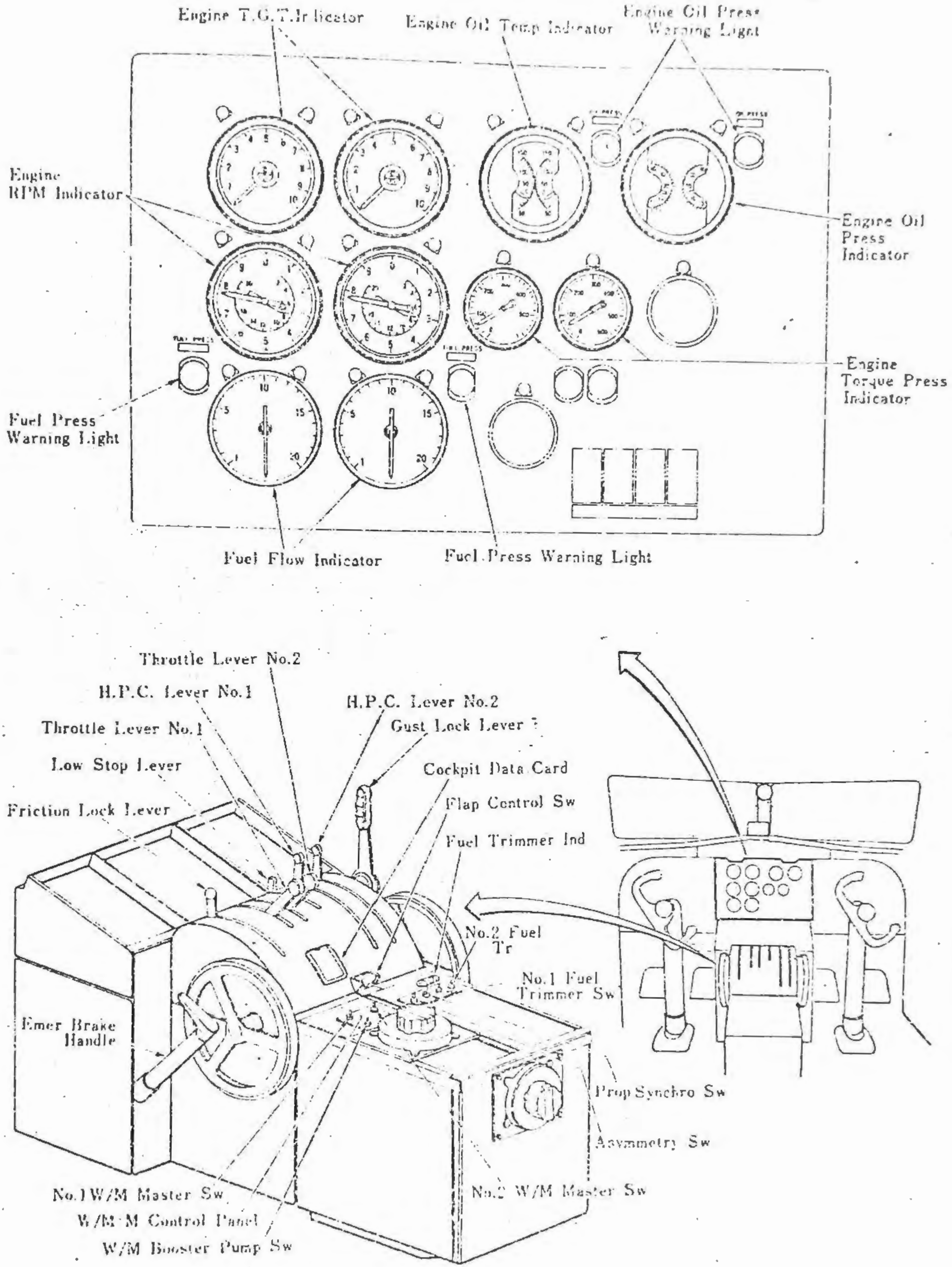
(1) When the gust lock is "ON," both throttle levers can not simultaneously be moved forward to MAX POWER position.

(2) When the gust lock is "ON," the low stop lever can not be moved from "GROUND" position to "FLIGHT" position.
Also, when the low stop is in "FLIGHT" position, the gust lock can not be applied.

(3) When the gust lock is "OFF," both throttle levers are movable simultaneously forward to MAX POWER position.
The low stop lever also can be placed in "FLIGHT" position. Furthermore, if the throttle levers are moved forward to MAX, the low stop lever automatically comes to "FLIGHT" position. However, once the low stop lever is placed in "FLIGHT," the low stop lever can not go into "GROUND" position automatically even when the throttle levers have been moved back.

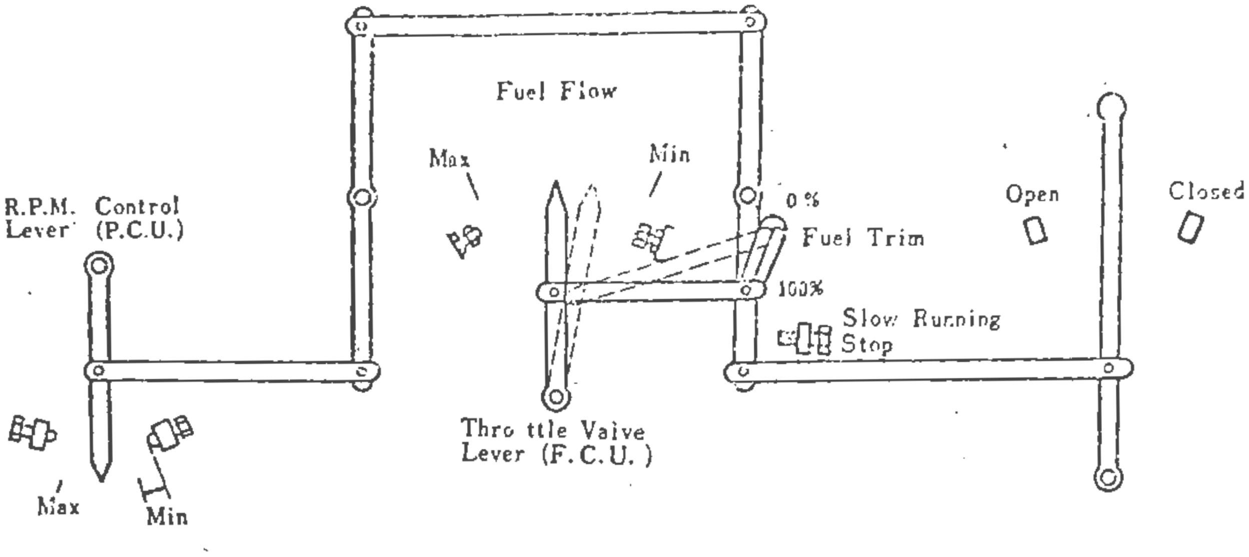
4.13.6 Engine Tachometer (Fig. 4-84)

In order to show the engine speed, each engine is fitted with a tachometer. The tachometer system includes a generator and an indicator. The tachometer generator is a 3-phase AC generator attached to the gear box, and functions to produce the electric voltages proportional to the engine speeds, indicating the voltage frequency by the indicator.
The indicator has two pointers: long and short ones. The long pointer is for the 100 rpm scale while the short pointer for the 1,000 rpm scale.
The indicator is provided with a green arc between 8,000 to 15,000 rpm and a red radial line at 15,050 rpm.



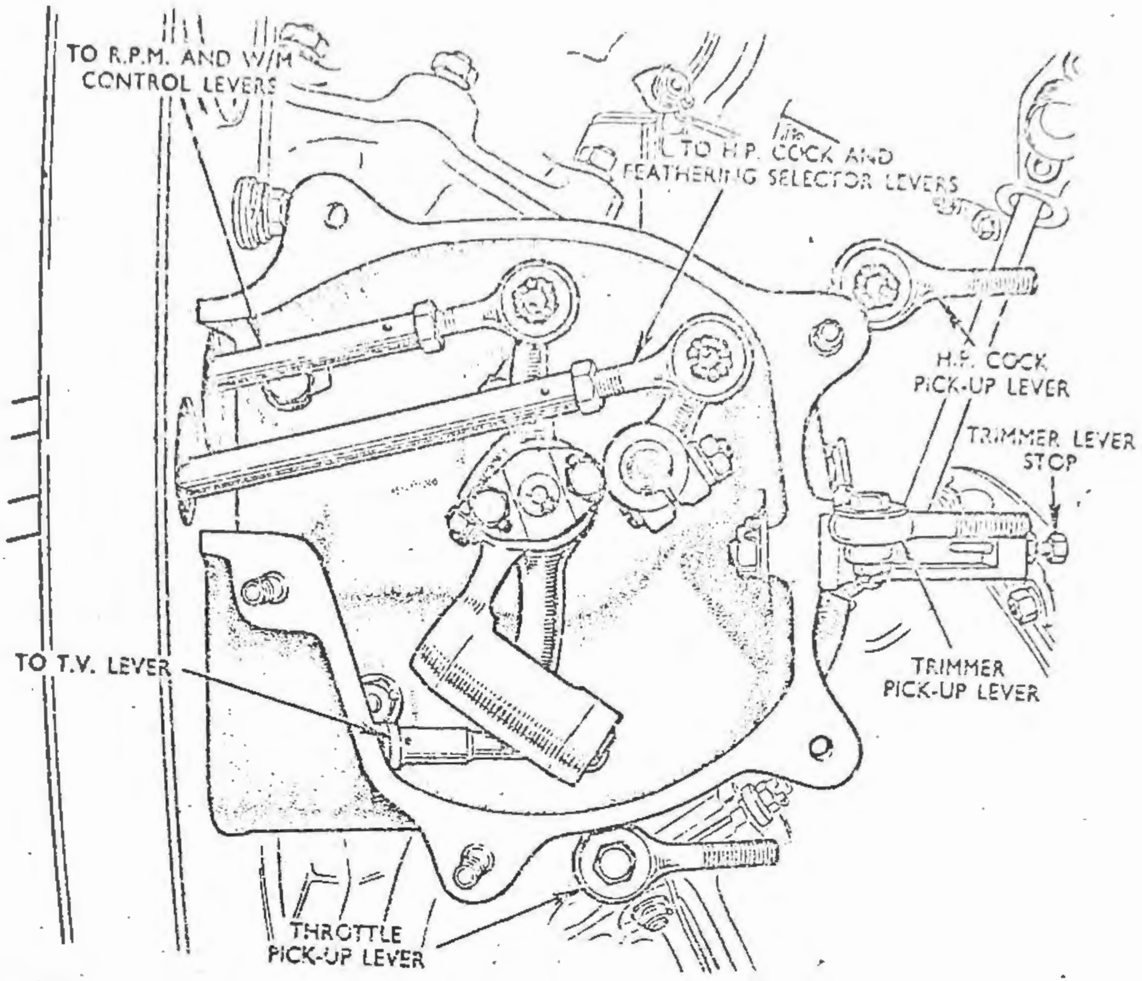
Pedestal & Instrument Panel

Fig. 4-70

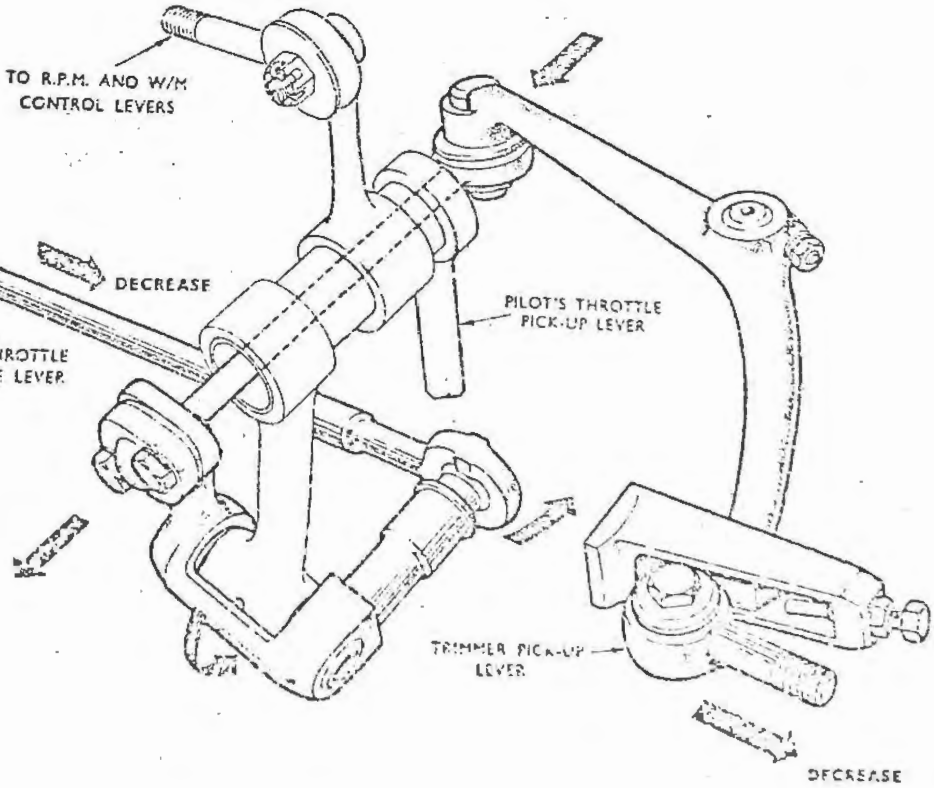


Interconnecton Of Engine Control

Fig 4 – 71

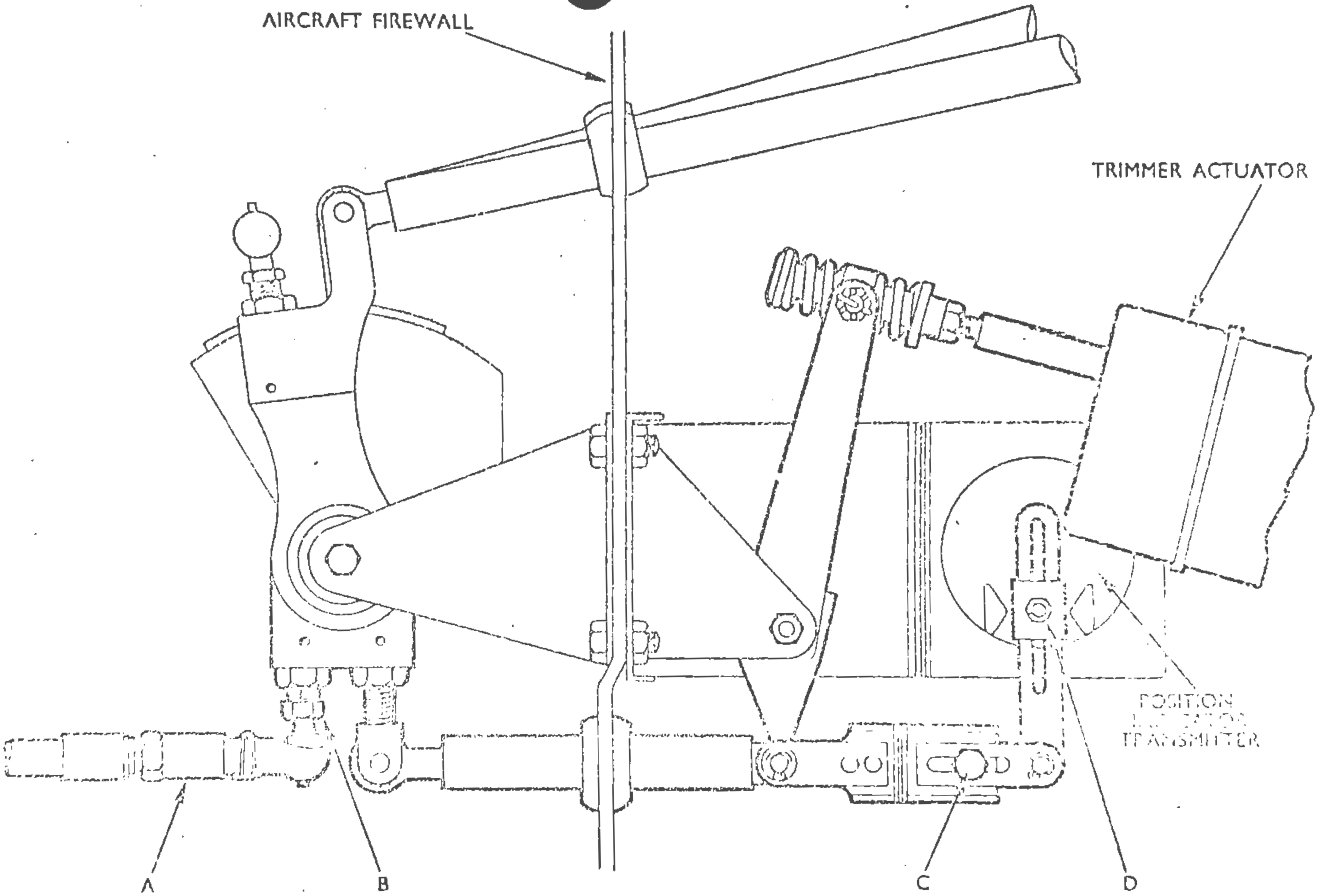


ENGINE CONTROL BOX


TO R.P.M. AND W/M CONTROL LEVERS
DECREASE
PILOT'S THROTTLE PICK-UP LEVER
TO THROTTLE VALVE LEVER
TRIMMER PICK-UP LEVER
DECREASE

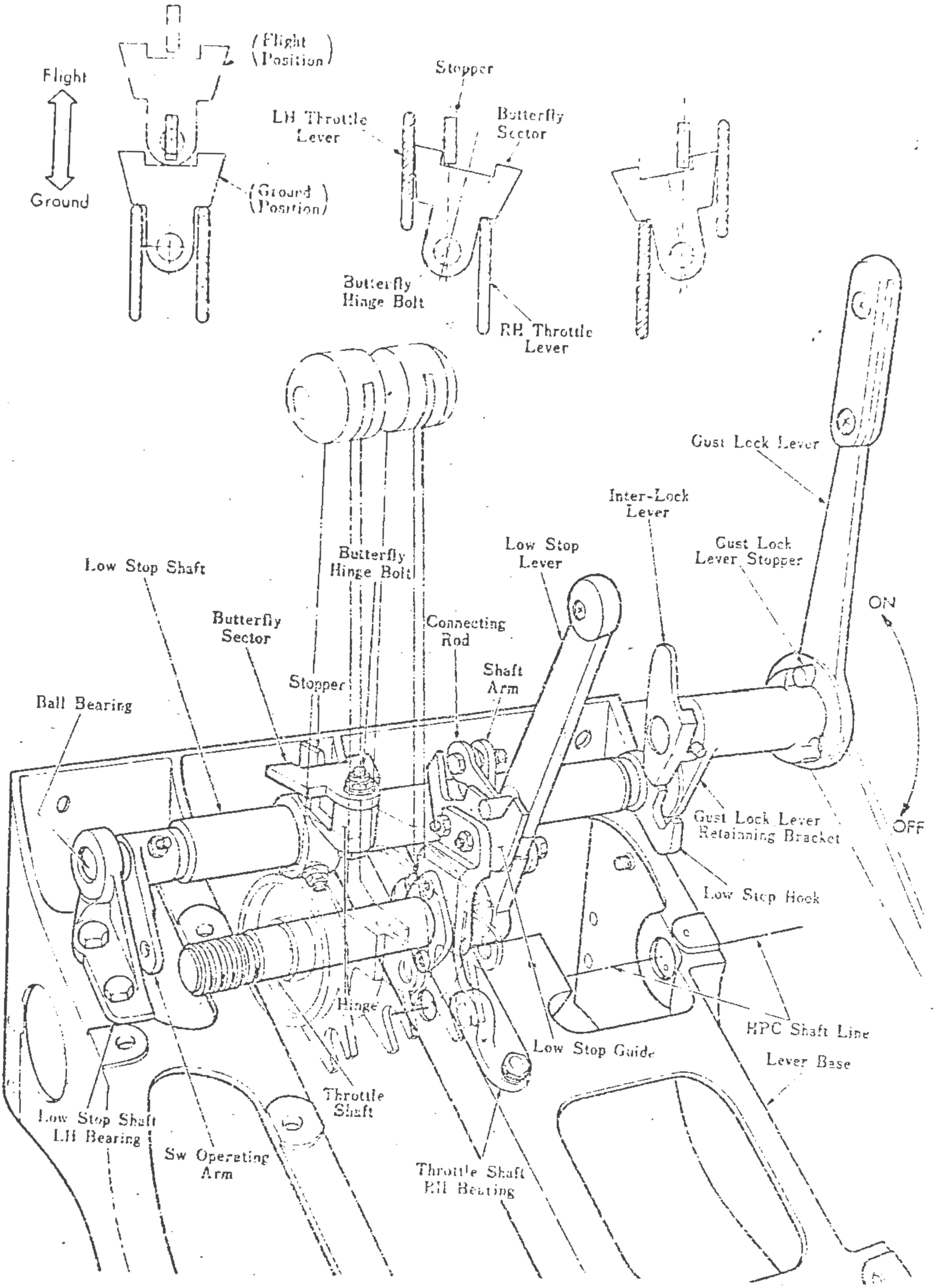
FUEL TRIMMER MECHANISM

Fig. 4-74



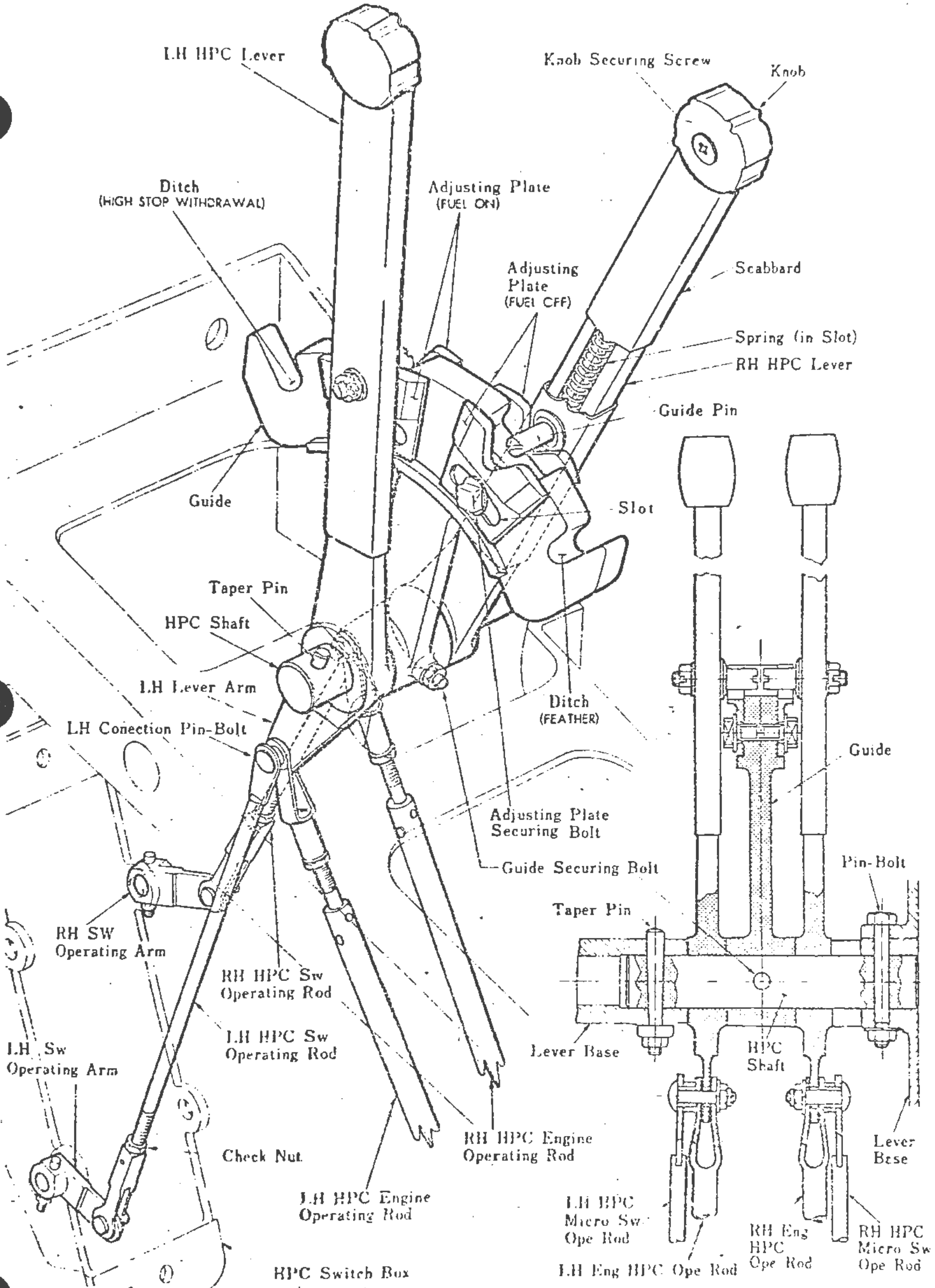
FUEL TRIMMER ACTUATOR LINKAGE

Fig. 4-75



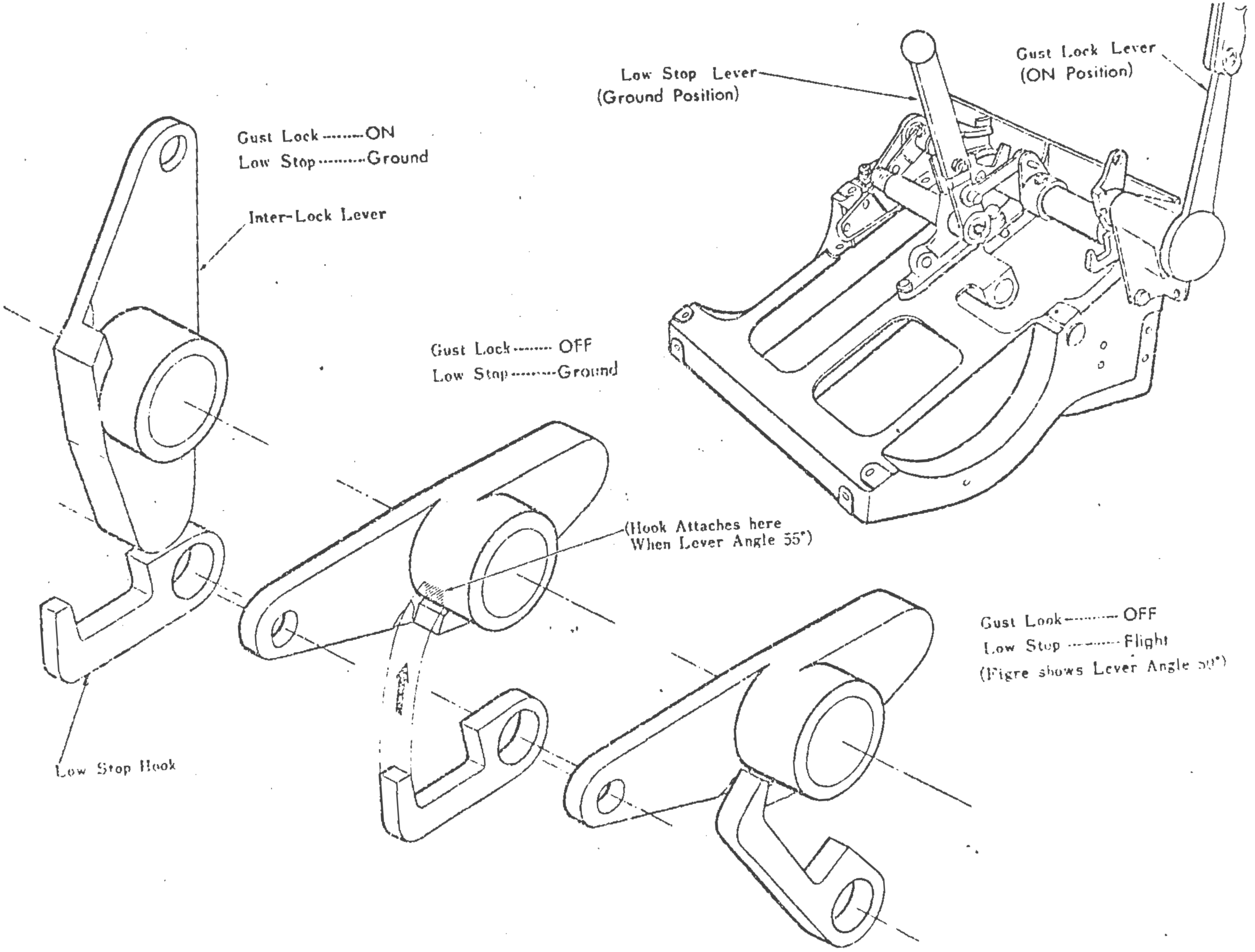
Gust Lock & Low Stop Lever on Pedestal

Fig. 4-76



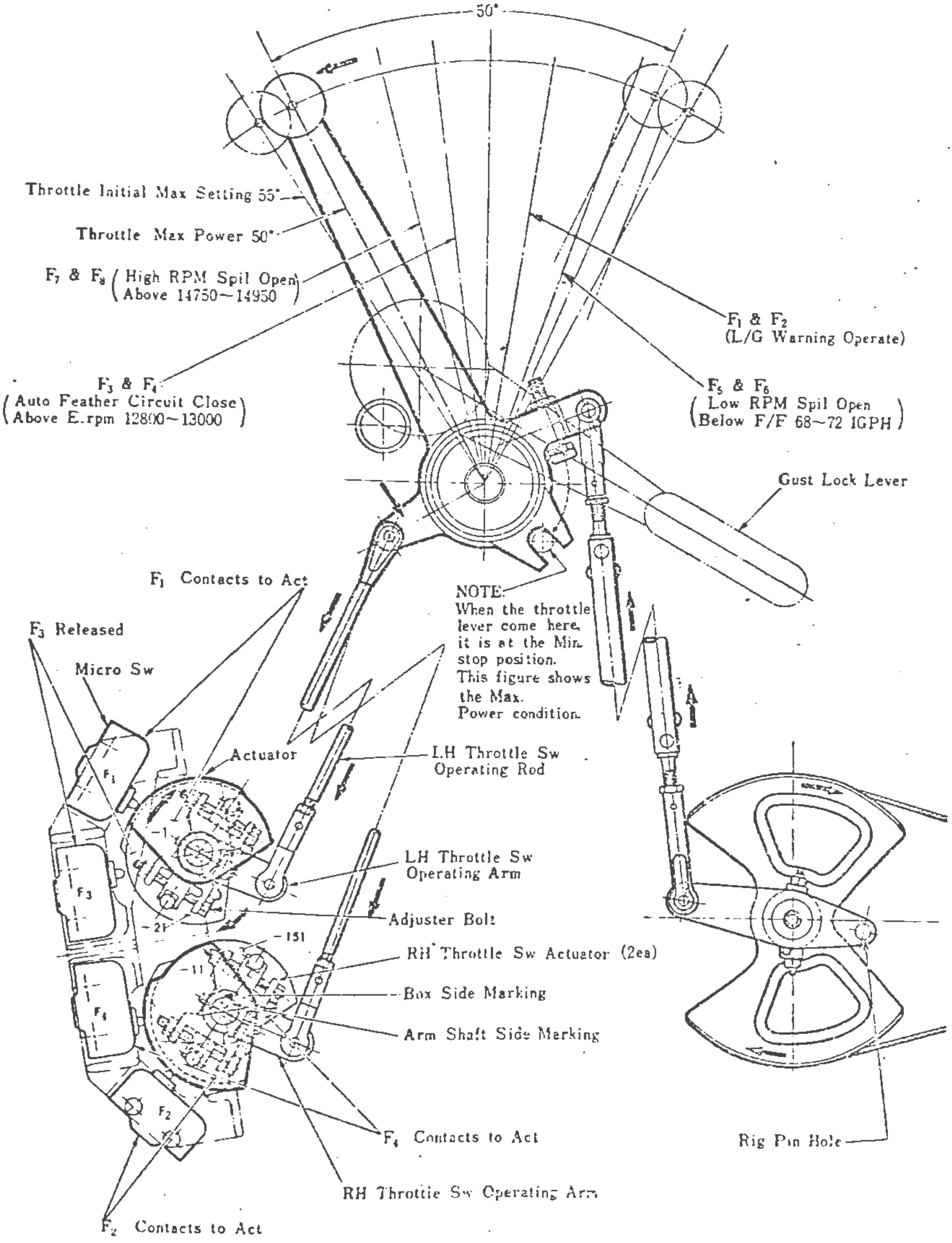
HPC Lever on Pedestal

Fig. 4-77



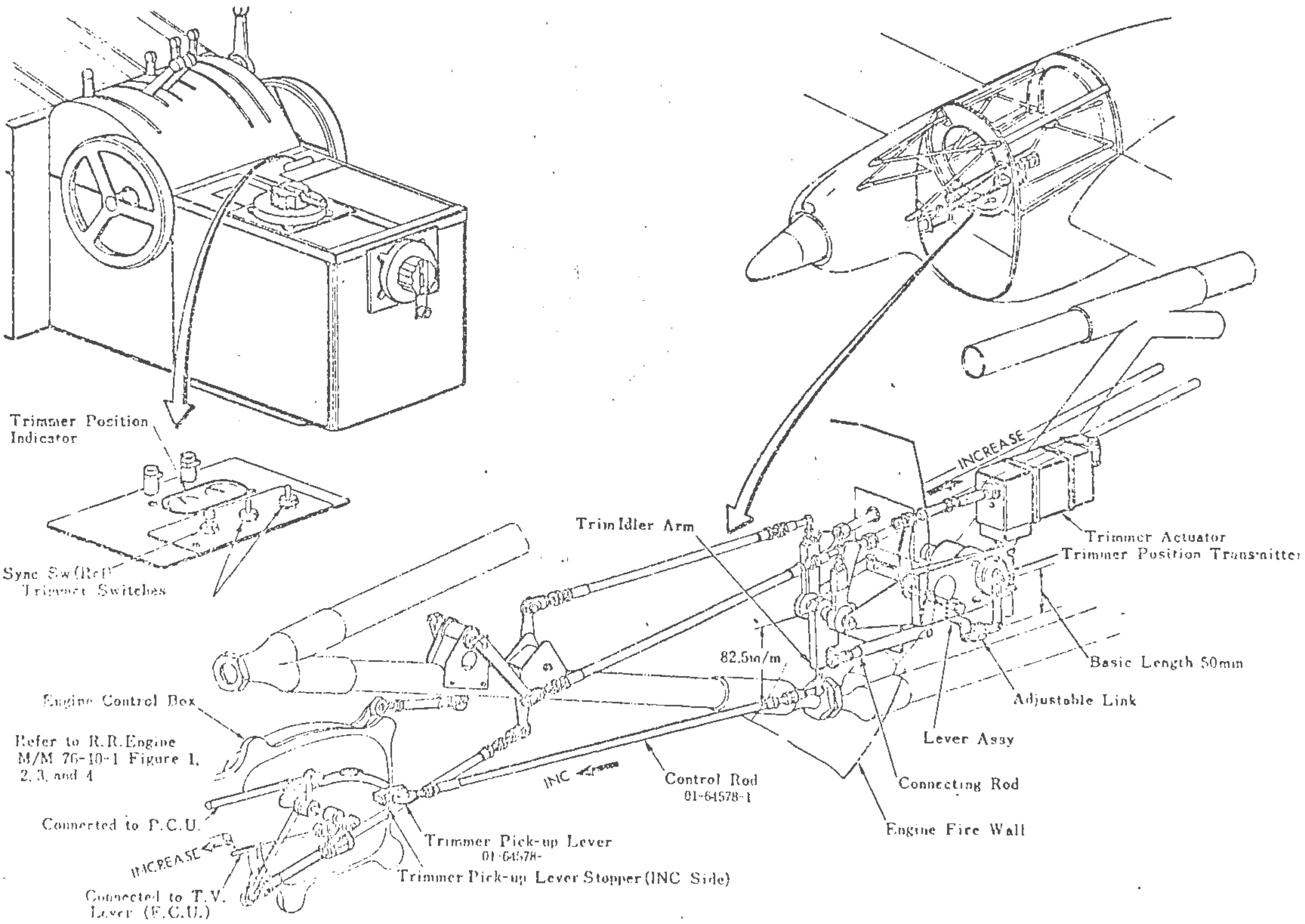
Interrelationship of Gust Lock and Low Stop

Fig. 4-78


50°
Throttle Initial Max Setting 55°
Throttle Max Power 50°
F₇ & F₈ (High RPM Spil Open Above 14750~14950)
F₁ & F₂ (L/G Warning Operate)
F₃ & F₄ (Auto Feather Circuit Close Above E.rpm 12800~13000)
F₅ & F₆ (Low RPM Spil Open Below F/F 68~72 IGPH)
Gust Lock Lever
NOTE: When the throttle lever come here, it is at the Min. stop position. This figure shows the Max. Power condition.
A
A
F₁ Contacts to Act
F₃ Released
Micro Sw
Actuator
LH Throttle Sw Operating Rod
LH Throttle Sw Operating Arm
Adjuster Bolt
RH Throttle Sw Actuator (2ea)
Box Side Marking
Arm Shaft Side Marking
F₁
F₃
F₄
F₂
-1
-21
-151
-11
F₄ Contacts to Act
RH Throttle Sw Operating Arm
F₂ Contacts to Act
Rig Pin Hole

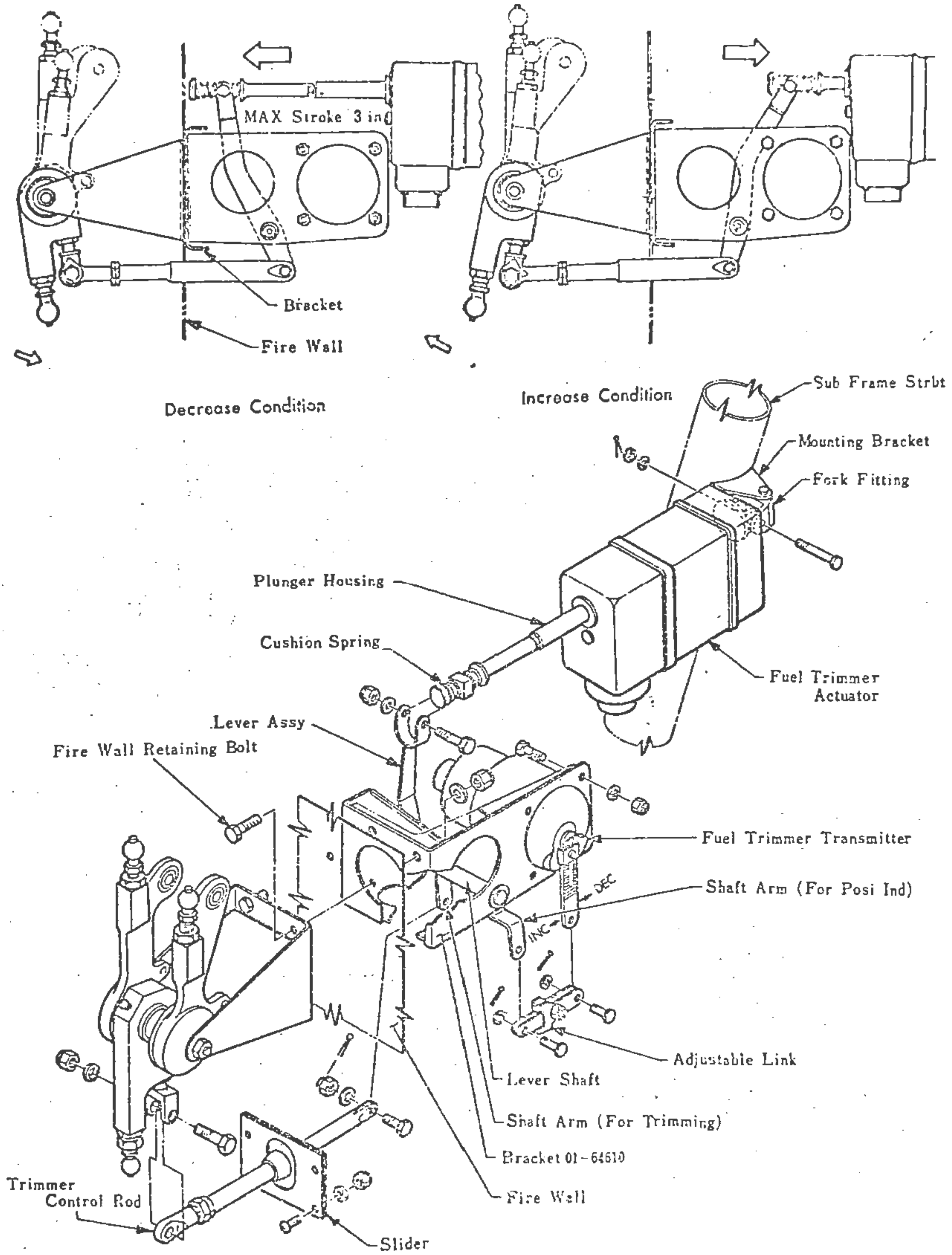
Operating Point of Throttle Lever

Fig. 4-79



Fuel Trimmer Control System General View

Fig. 4-80

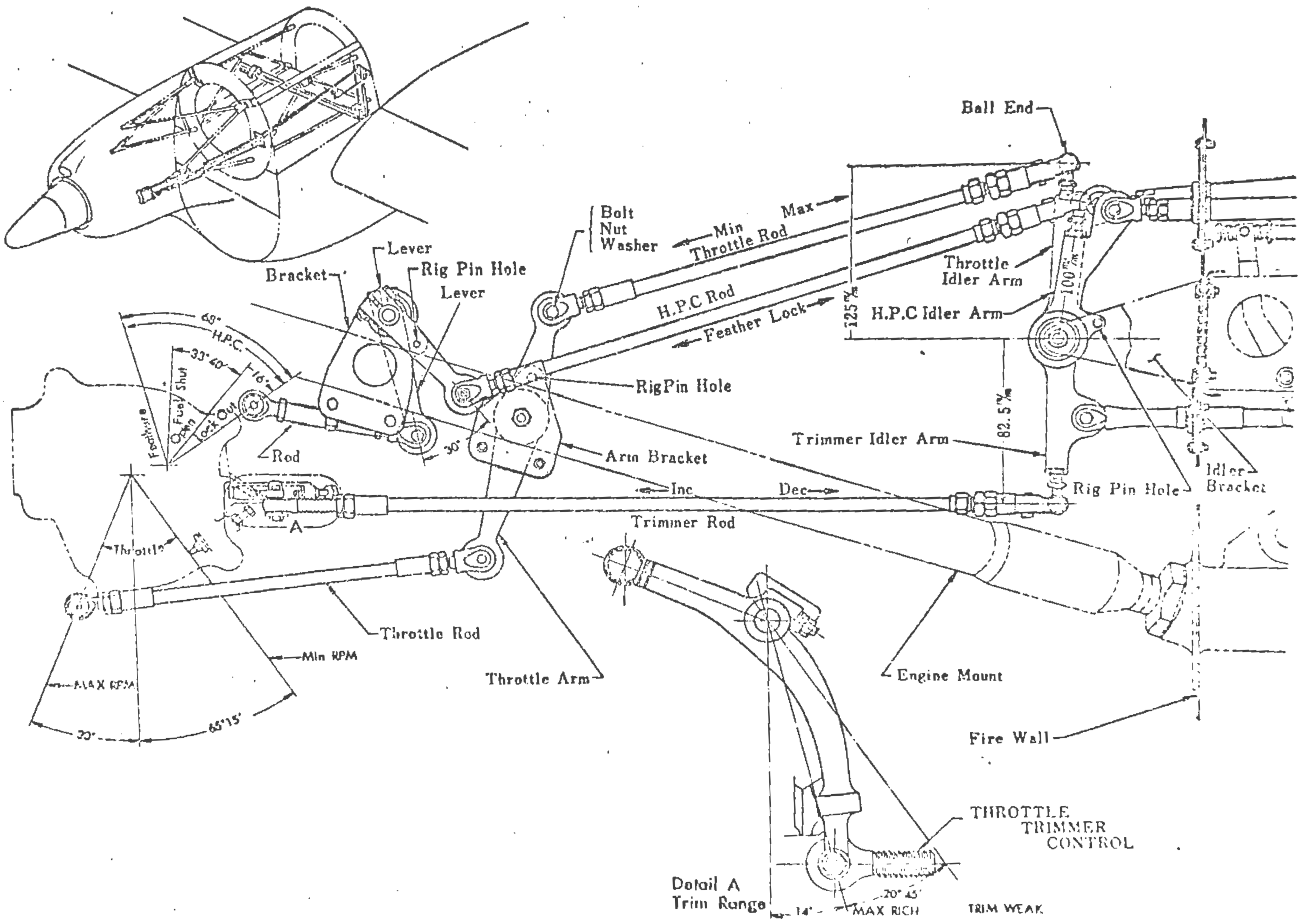


Decrease Condition

Increase Condition

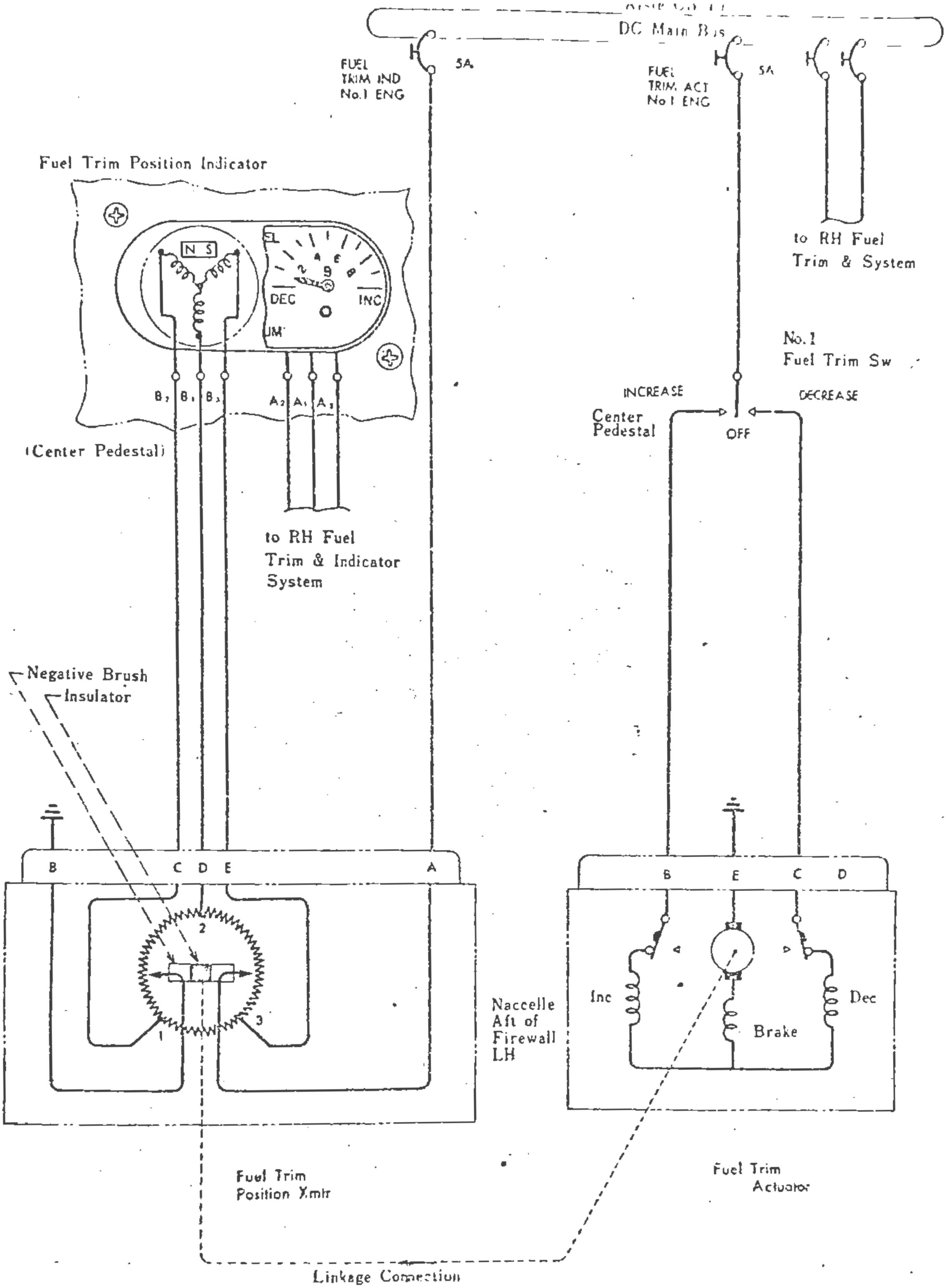
Fuel Trimmer Actuator & Transmitter

Fig. 4-81



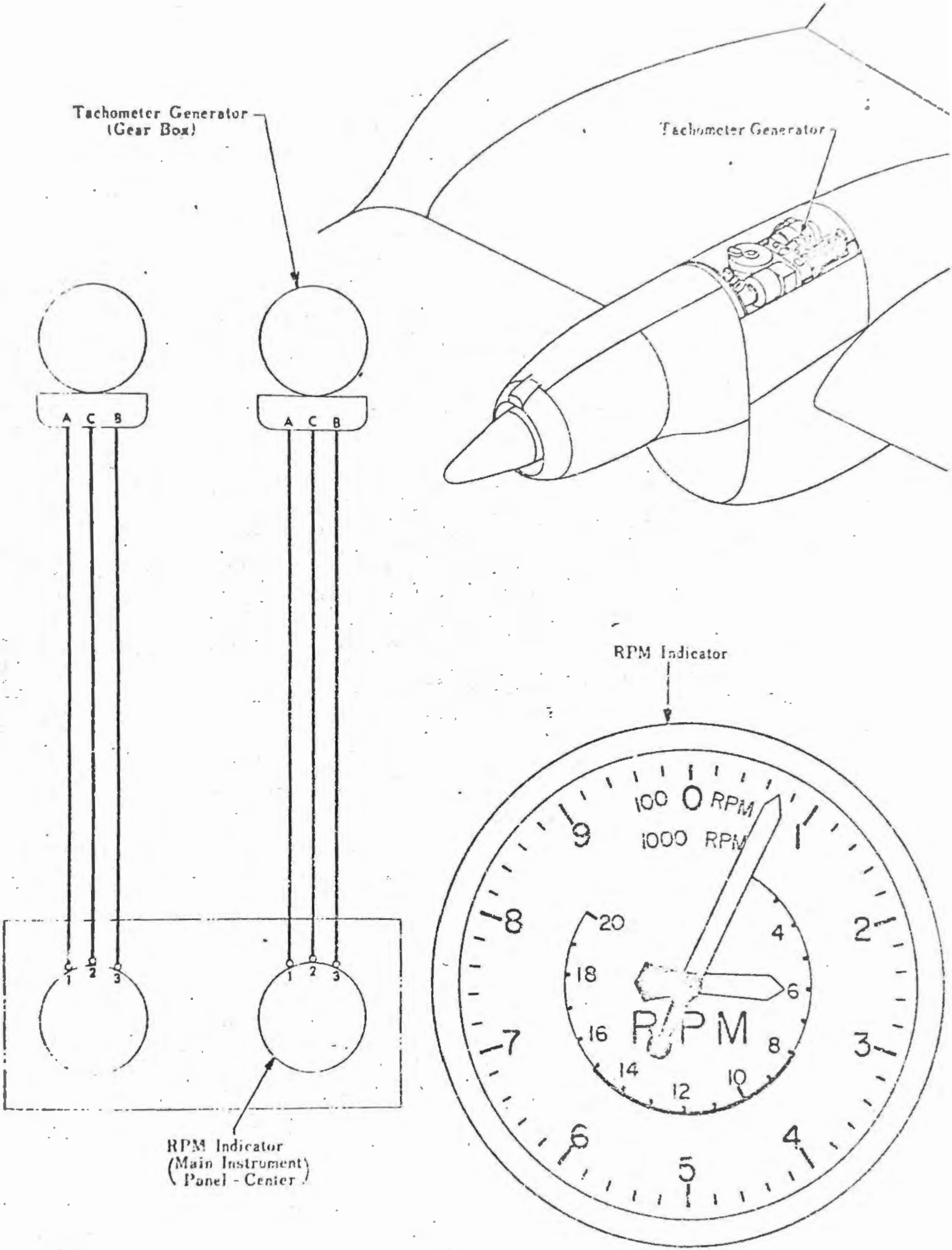
Push Pull Rod System in Engine Bay

Fig. 4-82



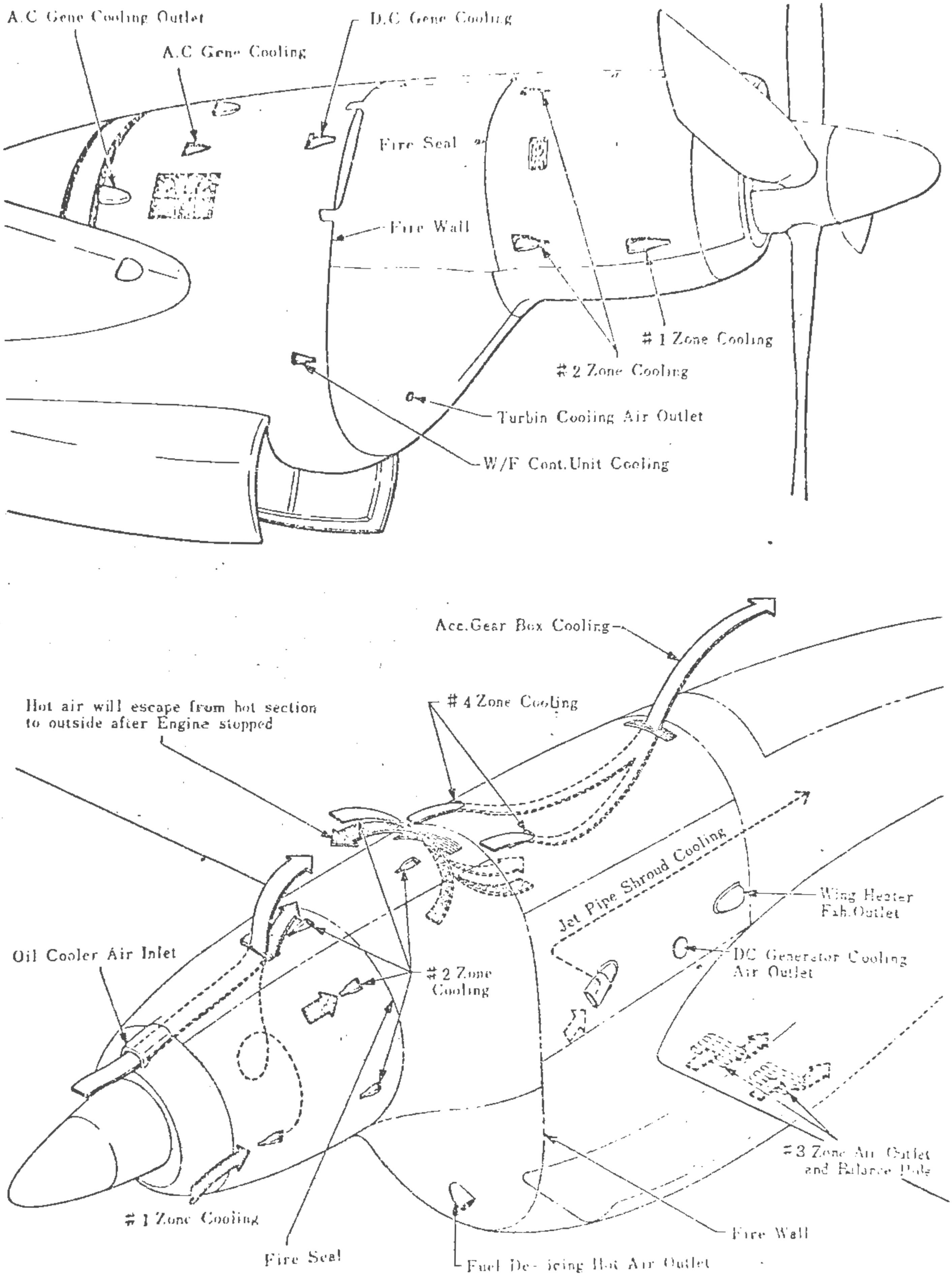
Fuel Trim & Indication System Schematic

Fig. 4-83



Engine Speed Theoretical Diagram

Fig. 4-94



Power Plant Cooling and Ventilation

Fig. 4-85

4.15 Exhaust System

4.15.1 General (Fig. 86)

The duty of the exhaust system is to send the hot exhaust air from the engine turbine through the exhaust pipe and discharge to the rear of the nacelle over the upper surface of the main wing.
The exhaust pipe consists of exhaust cone shroud, jet pipe, blanket, and jet pipe shroud. At the front end, the exhaust cone shroud is bolted to the aircraft fire wall while at the rear it is supported at a point where the support fitted to the jet pipe can be freely movable to allow for thermal expansion. The exhaust cone shroud is attached to the jet pipe shroud outside at the rear end and to the jet pipe inside each by means of the flexible joint.
Both the right and left exhaust pipes are identical and only the rear support attachments are asymmetrical.
The exhaust cone shroud is surrounding the engine exhaust unit; and for the effective cooling of Zone 2, the cooling air for Zone 2 is introduced through the gap between the shroud and the exhaust unit to the jet pipe by virtue of the venturi effect of the exhaust gas flowing from the exhaust unit into the jet pipe. The jet pipe is covered with blanket and further with the shroud to prevent overheating the surrounding structure.
The cooling air coming from the air intake located in the side of the nacelle flows through the inlet in the exhaust cone shroud and discharged from the rear end after passing through between the blanket and the jet pipe shroud.
For the purpose of preventing the reverse flow of the exhaust gas from the jet pipe into the nacelle, the gap between the exhaust pipe and the nacelle structure is sealed by sealing cloth at the rear end of the nacelle.

4.15.2 Exhaust Cone Shroud (Fig. 4-88)

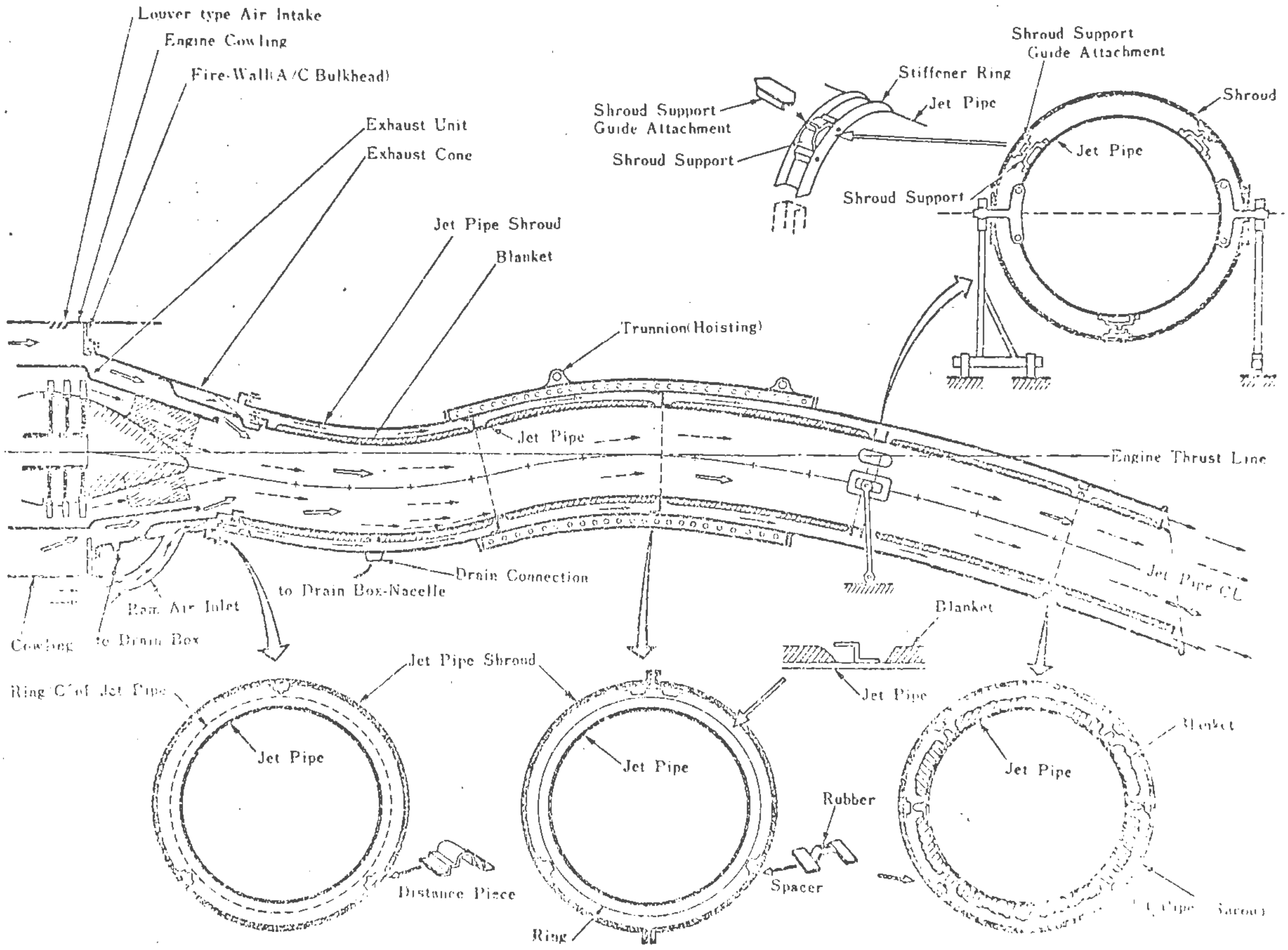
The exhaust cone shroud is of a seam welded construction of 0.032 in.-thick 347 corrosion resistant steel, measuring 480mm in length, 635mm in diameter at the front and 600mm in diameter at the rear. The rear half portion is of a double coaxial construction, to which the cooling air from the air intake in the nacelle side is introduced.

4.15.3 Jet Pipe

The jet pipe is a seam welded construction of 0.032 in. thick 347 corrosion resistant steel, measuring 419.1mm in inside diameter and 3,500mm in length. It has a curved portion along the contour of the upper surface of the main wing.

4.15.4 Blanket (Fig. 4-90)

The blanket, 0.5 in. thick, is an adiabatic material covered with corrosion resistant steel leaves. The adiabatic material, which is made of laminated refrasil fibrous silica, is very light in weight and so highly resistant to high temperatures up to 1,000°C that it is best suited for use as a heat and electric insulator as well. The stainless steel sheets, 0.003 in. thick outside and 0.004 in. thick inside, are corrugated for strength and free expansion and shrinkage, with its edges welded for the prevention of ingress of water, fuel, etc.



Exhaust System Functional Schematic

Fig. 4-86

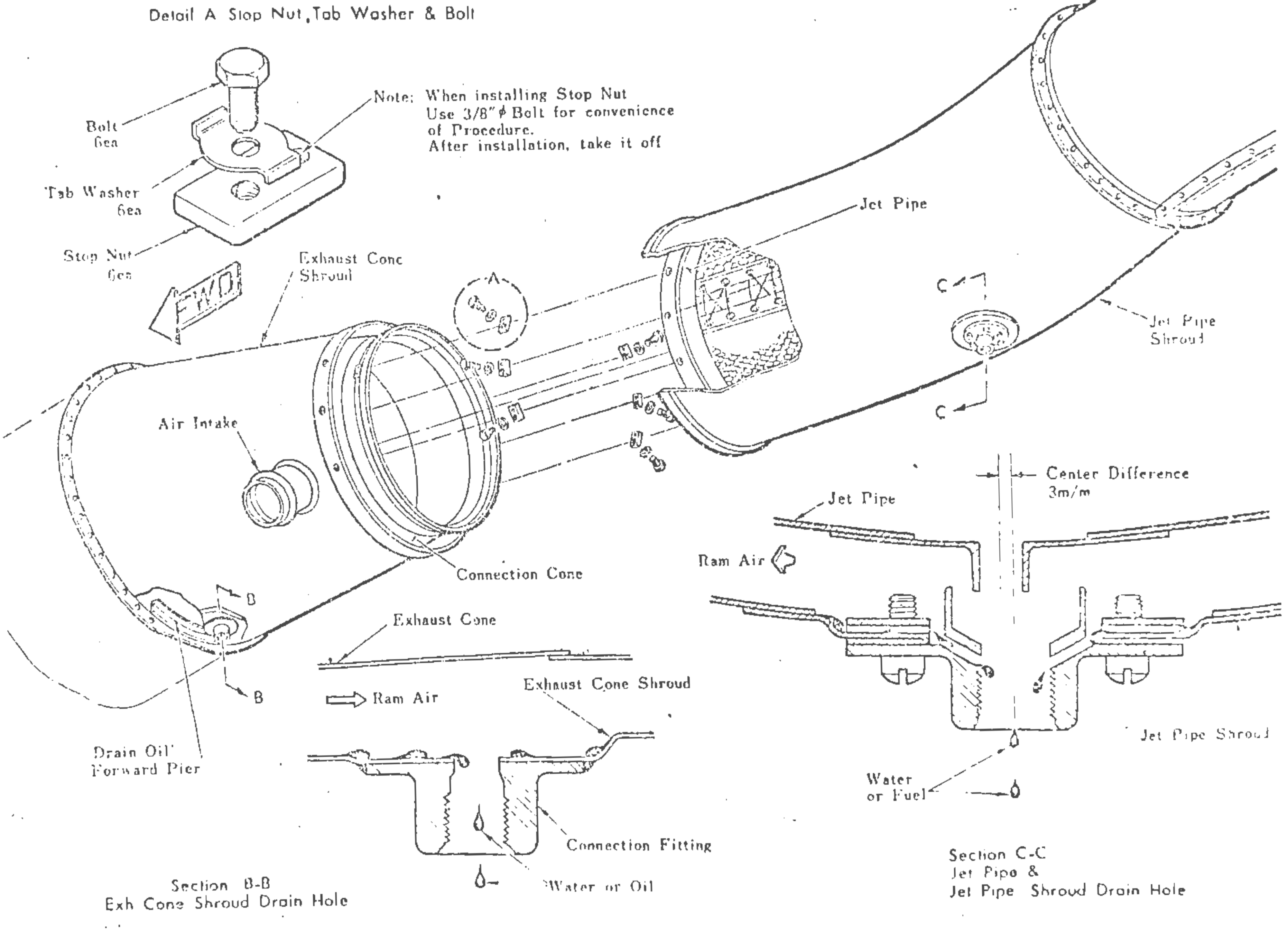
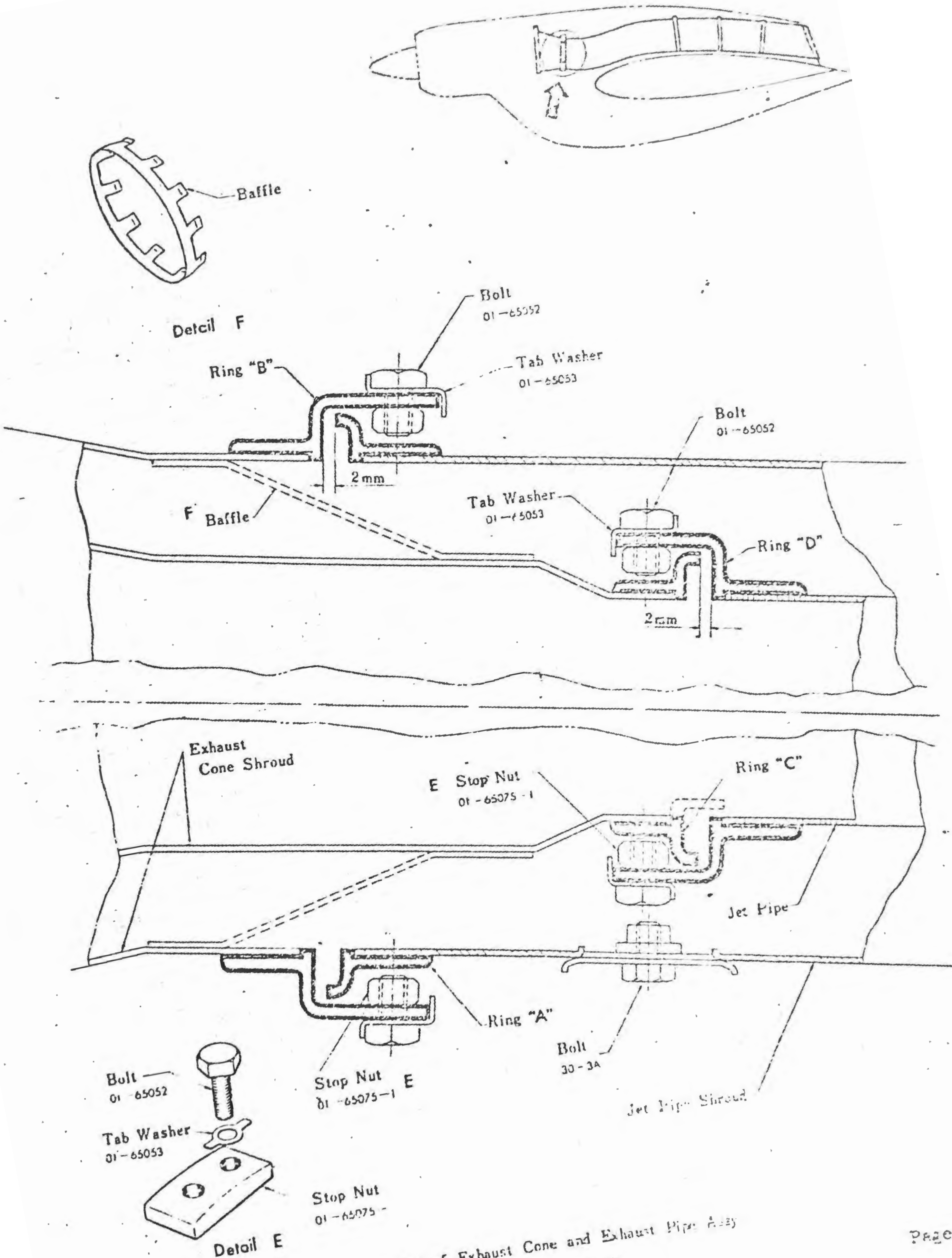


Fig. 4-87 Installation of Joint & Drain



Joint of Exhaust Cone and Exhaust Pipe Assy

Fig. 4-68

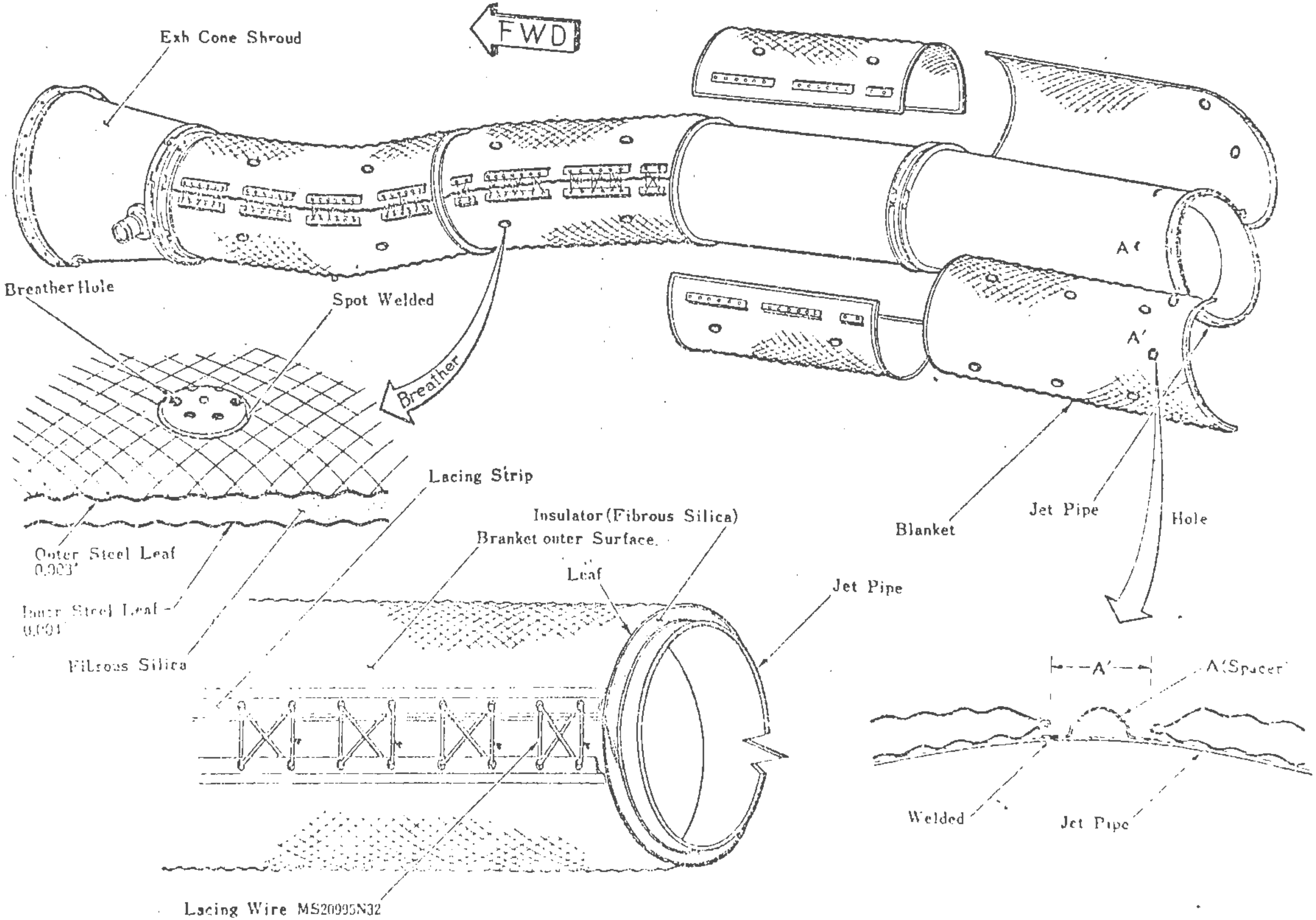


Fig. 4-90

Blanket

Also for the purpose of eliminating pressure difference between the inside and outside of the blanket likely to be encountered at the time of engine start and by change of operating conditions, the blanket is provided with breather holes each fitted with a screen to prevent the ingress of liquid. The blanket is divided into four pieces to the shape of the jet pipe, each piece being separated into upper and lower parts.

4.15.5 Jet Pipe Shroud (Fig. 4-89)

The jet pipe shroud is made up of bolt-jointed 0.025 inch thick 2024-T4 seam welded pipes measuring 470mm in inside diameter. It is divided into three parts.
On the lower surface of the lower part of the curved portion, the drain connection is provided at the jet pipe drain hole. The fuel drained into the jet pipe is led from here to the drain box inside the nacelle.
The intermediate portion is divided into two parts, right and left, with their upper and lower flanges fixed with bolts.
At two points, front and rear, of the upper flange are trunnions for hoisting exhaust pipe for its removal and installation.

4.16. Ice Protection System

4.16.1 General

Air intake, propeller, and spinner are provided with electrical ice protection system. The propeller and spinner ice protection system is described later.
Heaters for propellers, spinners and air intakes are supplied with electric power intermittently. The length of time for power supply may vary from "SLOW" to "FAST" or vice versa by means of the cockpit switch.
The fore part of the air intake is continuously supplied with the electricity.
The power utilized by the ice protection heaters is the wild frequency AC power obtained from the alternator. In order to prevent overheating the heaters on the ground, the electric voltage can be lowered when the low stop lever is in "GROUND" position.

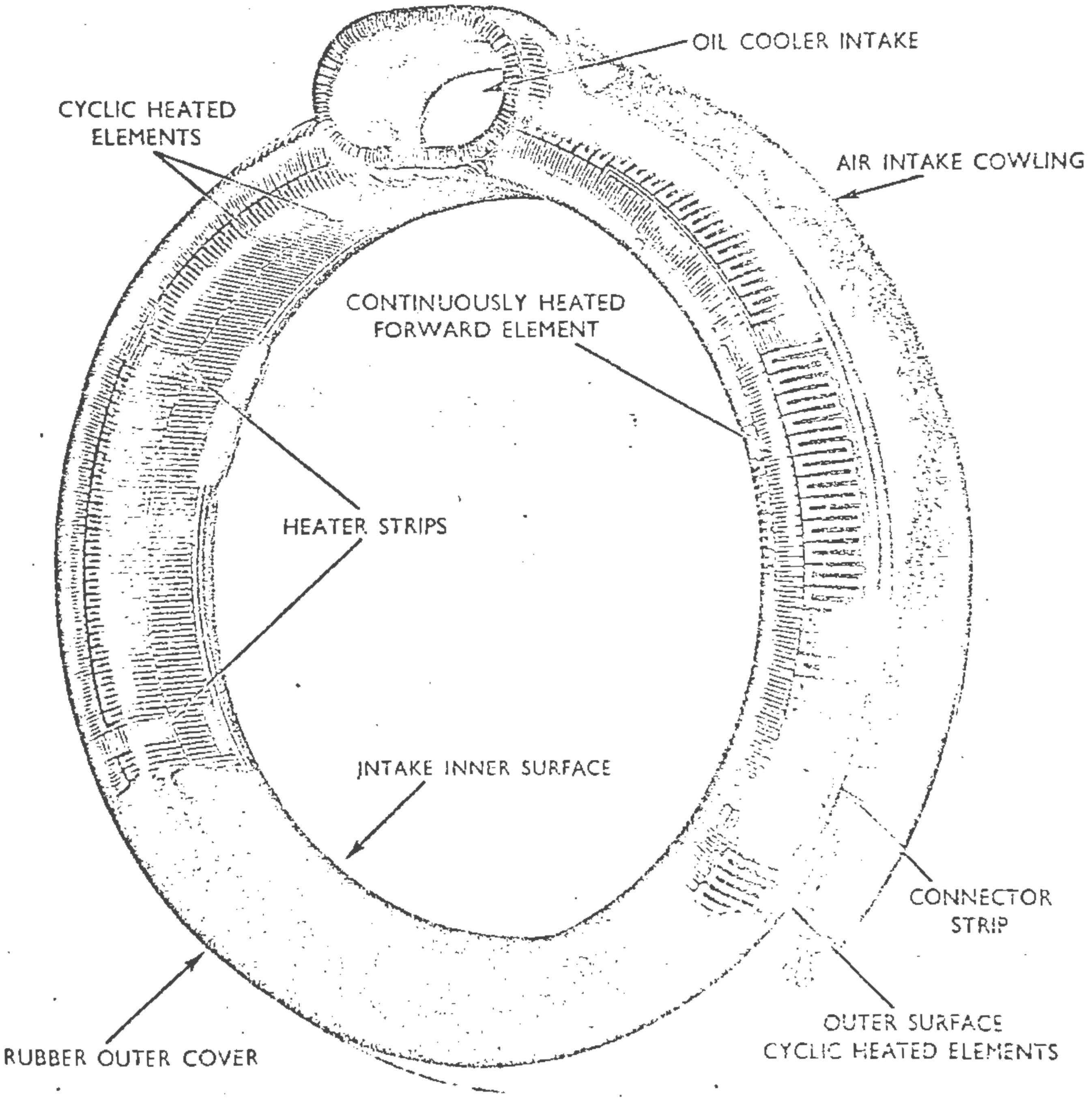
4.16.2 Operation

When using the de-icer, turn on the alternator switch and then the de-icing master switch. Subsequently set the cycling speed selector switch to "FAST" or "SLOW."
In "FAST" position, the de-icing cycle is 80 seconds.

0 to 20 sec. ..... Air intake side heater ON
20 to 40 sec. ..... Propeller and spinner ON
40 to 80 sec. ..... All intermittent currents OFF
Air intake front side only.

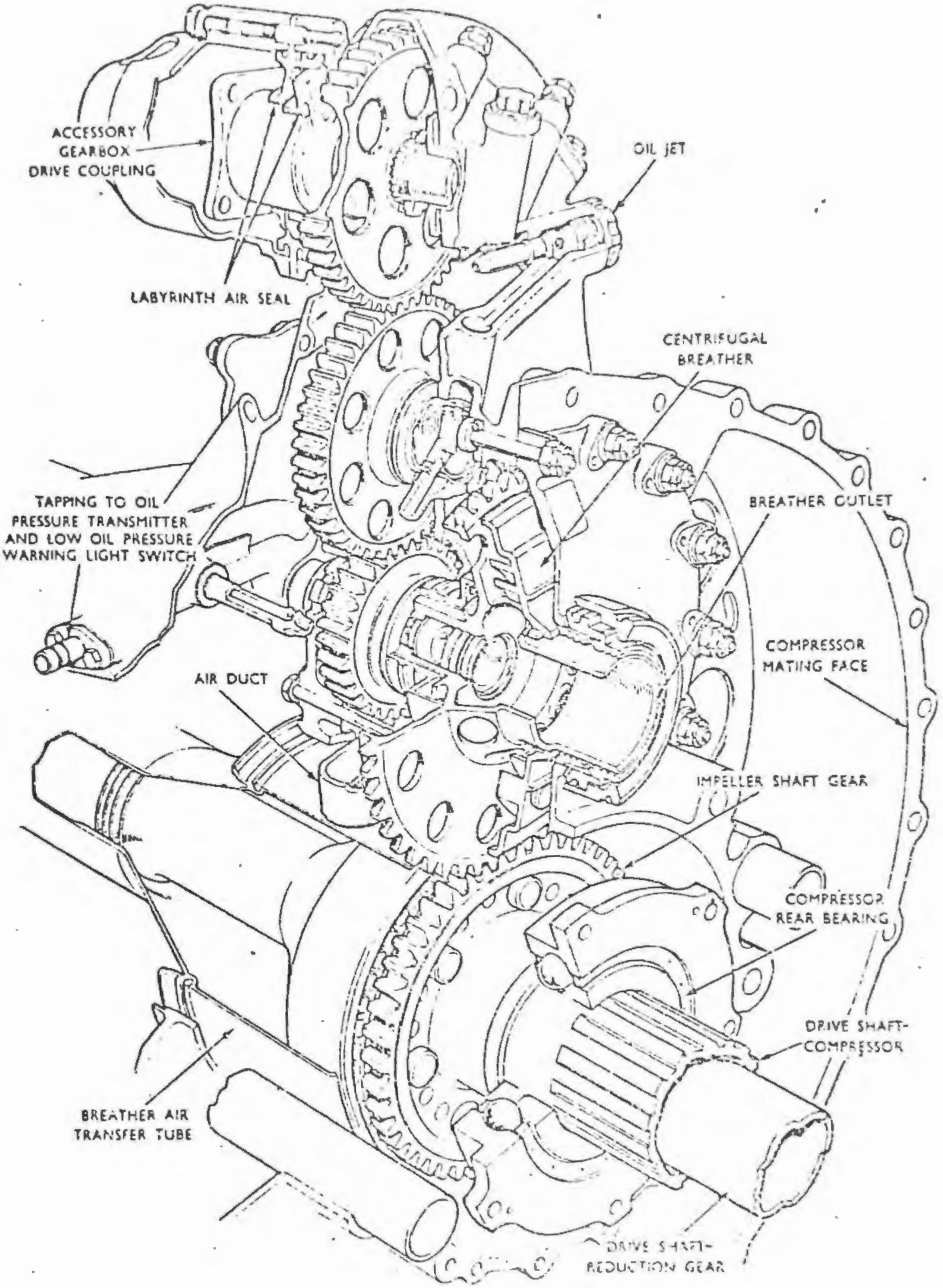
In "SLOW position, the de-icing cycle is 240 seconds.

0 to 60 sec.
60 to 120 sec.
120 to 240 sec.



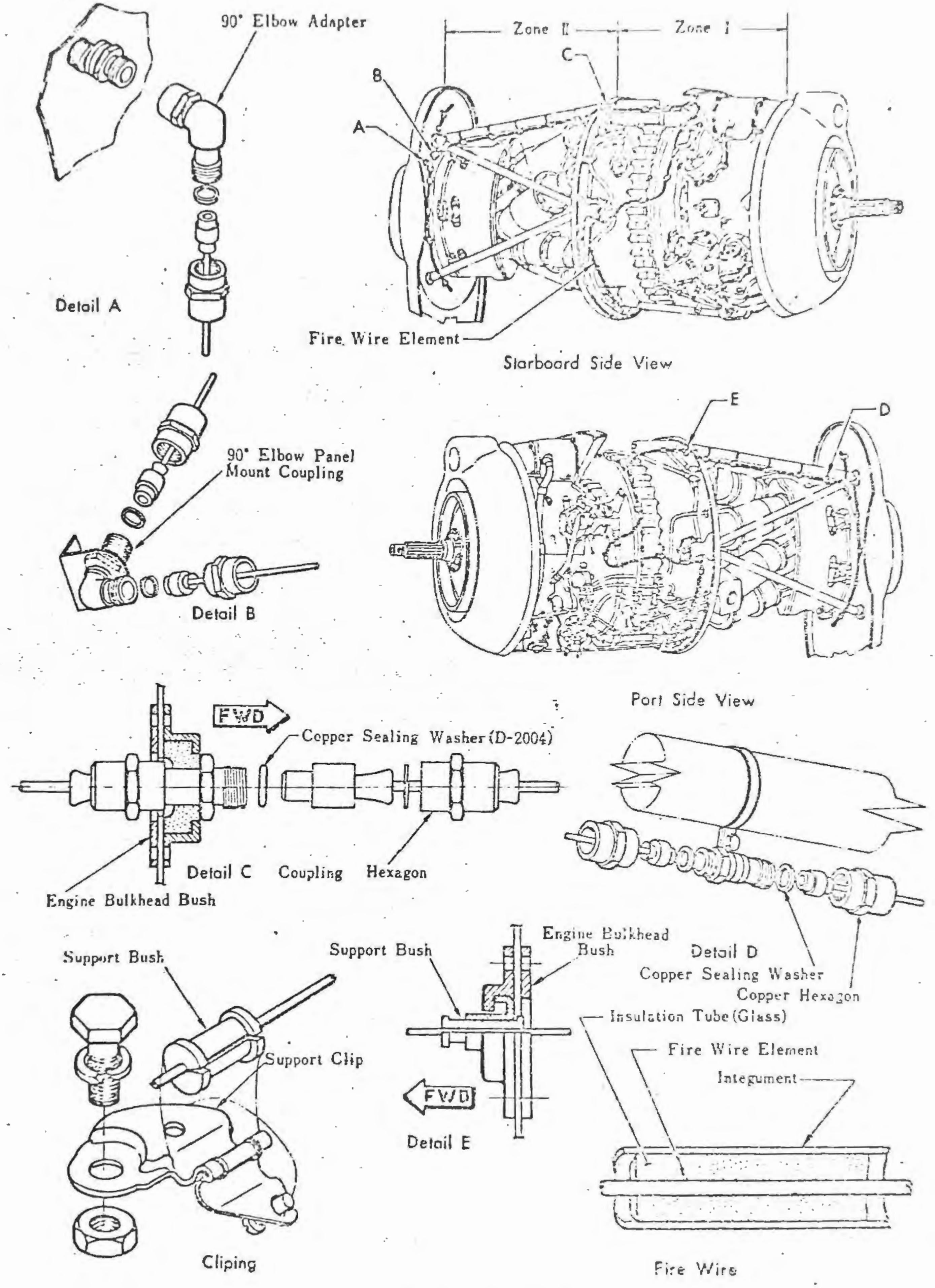
AIR INTAKE DE-ICING

Fig. 4-91


ACCESSORY GEARBOX DRIVE COUPLING
OIL JET
LABYRINTH AIR SEAL
CENTRIFUGAL BREATHER
TAPPING TO OIL PRESSURE TRANSMITTER AND LOW OIL PRESSURE WARNING LIGHT SWITCH
BREATHER OUTLET
COMPRESSOR MATING FACE
AIR DUCT
IMPELLER SHAFT GEAR
COMPRESSOR REAR BEARING
DRIVE SHAFT-COMPRESSOR
BREATHER AIR TRANSFER TUBE
DRIVE SHAFT-REDUCTION GEAR

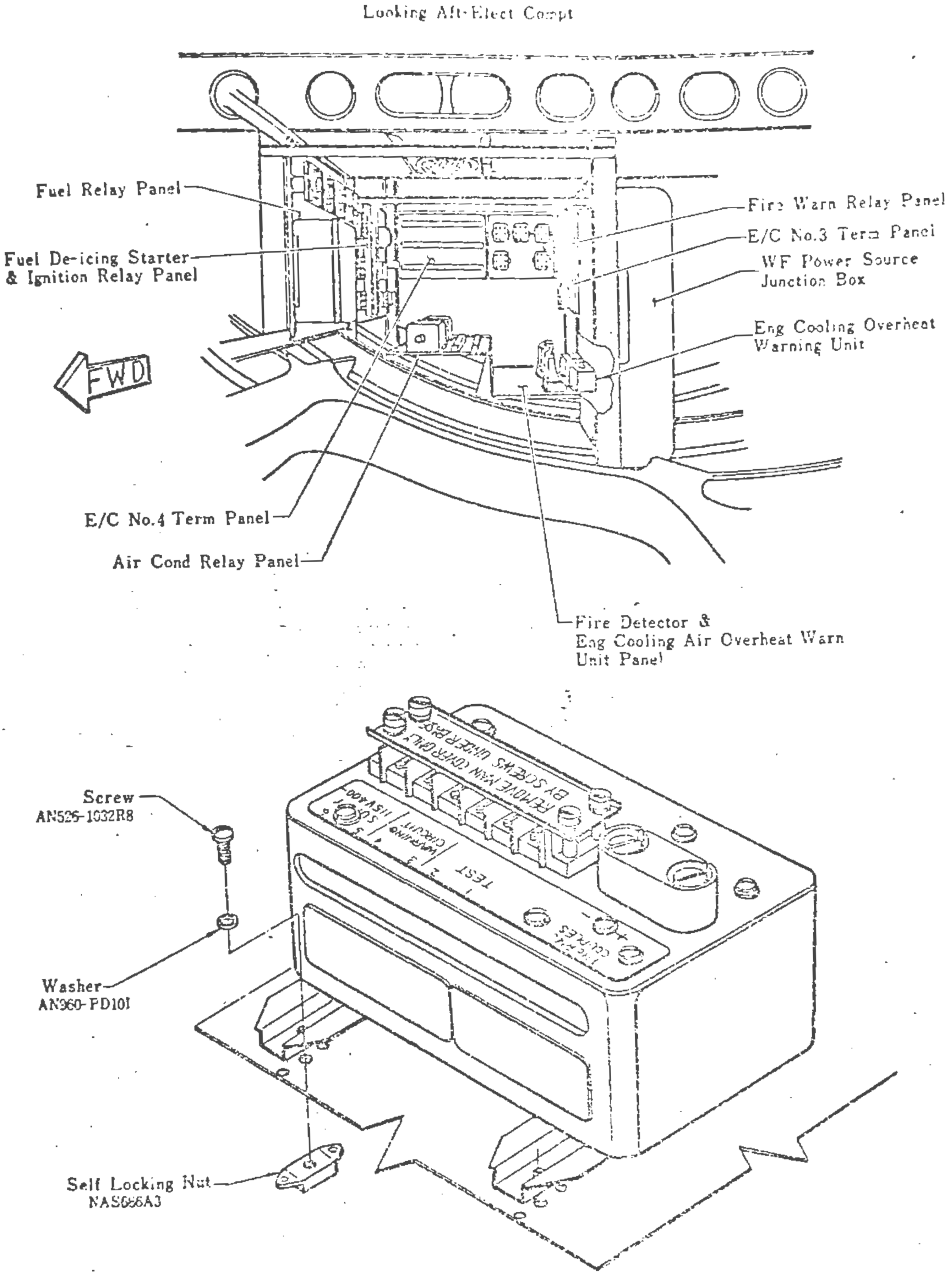
Accessory gearbox drive

Fig. 4-92



Engine Fire Wire Element

Fig. 4-97


Looking Aft-Elect Compt
Fuel Relay Panel
Fuel De-icing Starter & Ignition Relay Panel
FWD
E/C No.4 Term Panel
Air Cond Relay Panel
Fire Warn Relay Panel
E/C No.3 Term Panel
WF Power Source Junction Box
Eng Cooling Overheat Warning Unit
Fire Detector & Eng Cooling Air Overheat Warn Unit Panel
REMOVE MAIN COVER ONLY BY SCREWS UNDER BASE
SOURCE 115V400
WARNING CIRCUIT
TEST
Screw AN526-1032R8
Washer AN960-PD10L
Self Locking Nut NAS686A3

Engine Cooling Air Overheat Warning Unit Installation

Fig. 4-101

4.14 Cooling and Ventilation Systems

4.14.1 General (Fig. 4-85)

In this paragraph a description is given on the cooling and ventilation systems for the engine section and the gear box section.
The engine and gear box sections are equipped with the cooling and ventilation systems for the cooling of their main and accessory units and the ventilation of their zones.
The nacelle section is divided into the following four zones from the viewpoint of fire protection.

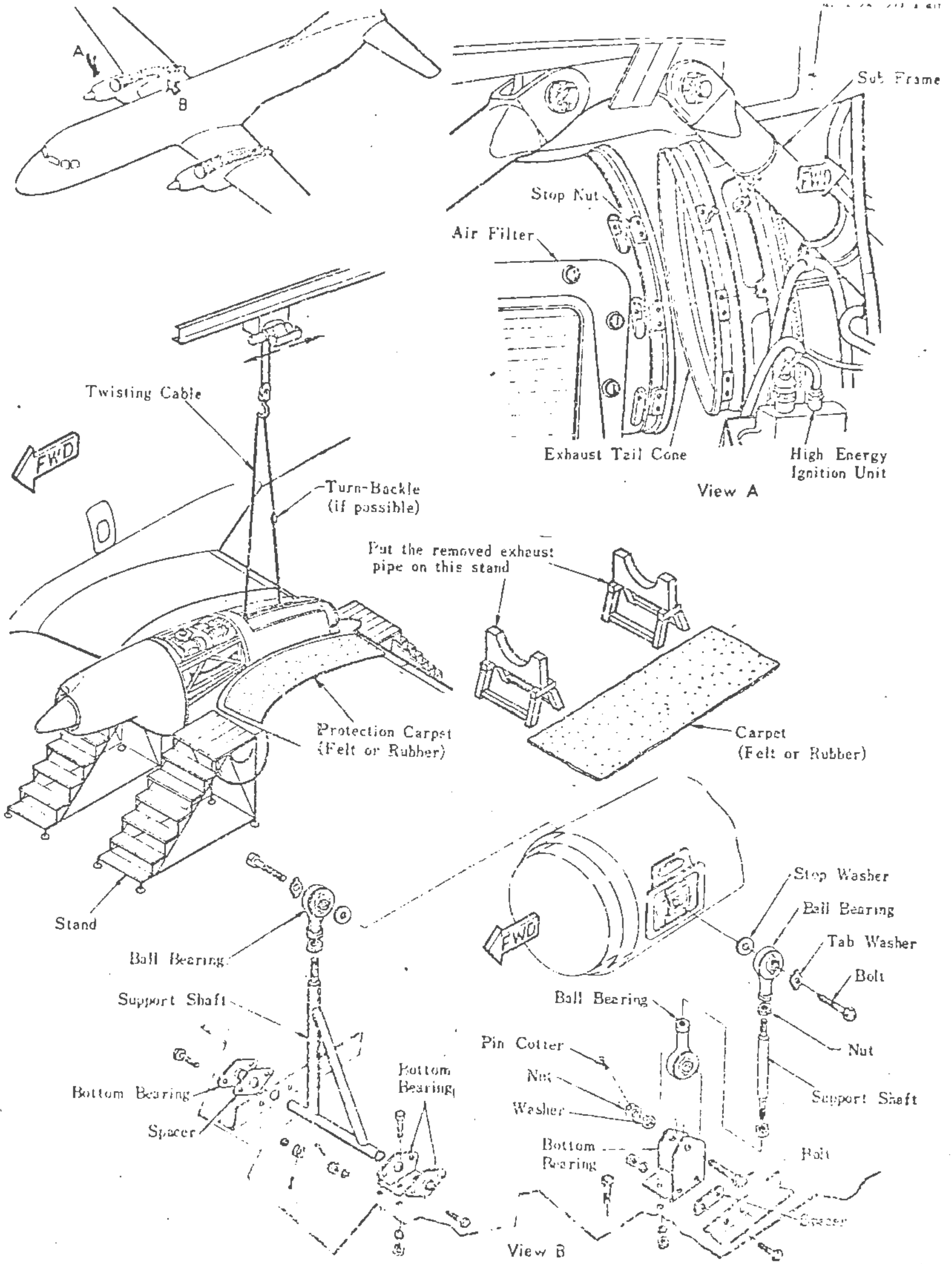
Zone 1: The fore part of the engine, ranging from the rear of the engine nose cowling up to the engine fire wall.

Zone 2: The hot part of the engine including combustion chambers and turbine, extending to the aft of the aircraft fire wall. The interior of the exhaust pipe also is included in Zone 2.

Zone 3: The nacelle section located to the aft of the aircraft fire wall, being divided into two part - Zone 3 Upper and Zone 3 Lower. These two parts are separated by the shear panel and main wing structure.

Zone 4: Accessory drive gear box zone situated to the fore, upper part of Zone 3 Upper and separated from Zone 3 Lower by an aluminium alloy bulkhead.

The cooling air for Zone 1 enters from the air intake scoops located one on the front, lower part of either panel of the cowling.
After cooling and ventilating Zone 1, the air is discharged from the engine oil cooler outlet port situated on the upper panel of the cowling.
In Zone 2, seven air intakes are provided in the cowling.
Two air intake scoops are in the right and left side panels of the cowling, another two in the upper cowling; and one louver type air intake in the rear of the upper cowling.
After cooling the heated engines, the air from the air intake flows into the jet pipe through the annular gap between the exhaust unit and the exhaust cone shroud, being discharged together with the engine exhaust.
The air intake scoop located on the upper panel has been so arranged as to provide the cooling air to cool the universal joints before and after the gear box drive shaft.
The louver type air intake is so designed that the air is taken in and the warmed air is let out from it in order to accelerate the cooling of the turbine section after the engines shut down.
The cooling air for Zone 4 enters from the two air intake scoops located to the fore of the gear box top cover, and after cooling the gear box and its accessories, is discharged from the louver type outlet situated to the aft of the gear box top cover.
Zone 3 Lower is ventilated by the air taken in from the air intake scoop on the right, front, lower side of the nacelle, after cooling the alternator control unit. The air is then let out from the louver type outlet located on the right of the nacelle, near the lower surface of the main wing.



Exhaust Pipe Assy Remove Installation

Fig. 4-89

The operating condition of the de-icer system can be seen by means of the alternator ammeter and the indicator light.
The red de-ice fail light indicates system failure; the orange timer fail light indicates the presence of a trouble with a cyclic timer switch and power supply.
The selection of cyclic switch is as follows.

Outside air temperature	True -15°C or higher ...... (Indication -10°C)	"FAST"
Outside air temperature	True -15°C or lower ...... (Indication -10°C)	"SLOW"

The de-icer of the aircraft is provided to prevent icing, not to remove ice; and accordingly the system must be used any time when the outside air temperature is below +10°C by reading and the presence of water contents is recognized. Refer to Chapter 12 ANTI-ICING SYSTEM.

4.17 Accessory Gear Box

4.17.1 General

Various engine accessories are fitted on the gear box.
The gear box is installed in the gear box chamber immediately above the exhaust pipe, to the aft of the aircraft fire wall, in each engine nacelle.
The gear box is driven by engine power through the drive shaft located above the engine.
The drive shaft has two universal joints and rotates 0.3448 time the engine speed, being capable of transmitting the torque of about 2,000 lbs.-in.

4.17.2 Accessories

The gear box is equipped with the following accessories.

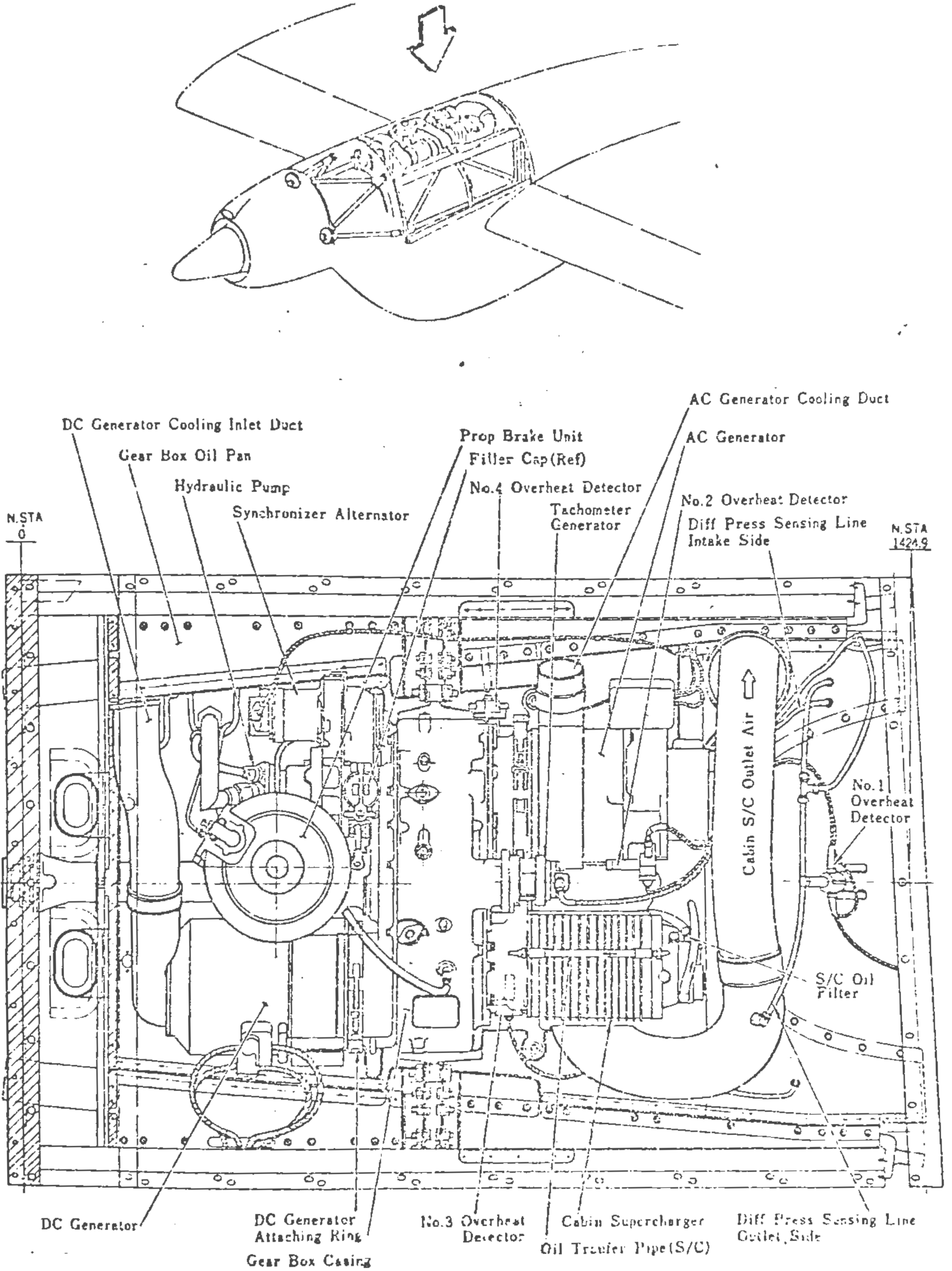
12kW DC generator	Speed ratio to gear box	1.6448
30kVA alternator		1.758
Hydraulic pump		0.77
Cabin air compressor		2.333
Synchronizer alternator		1.077
Tachometer generator		0.725

The left-hand gear box is fitted, beside these, with the propeller brake.

Propeller brake	Speed ratio to gear box	1.071

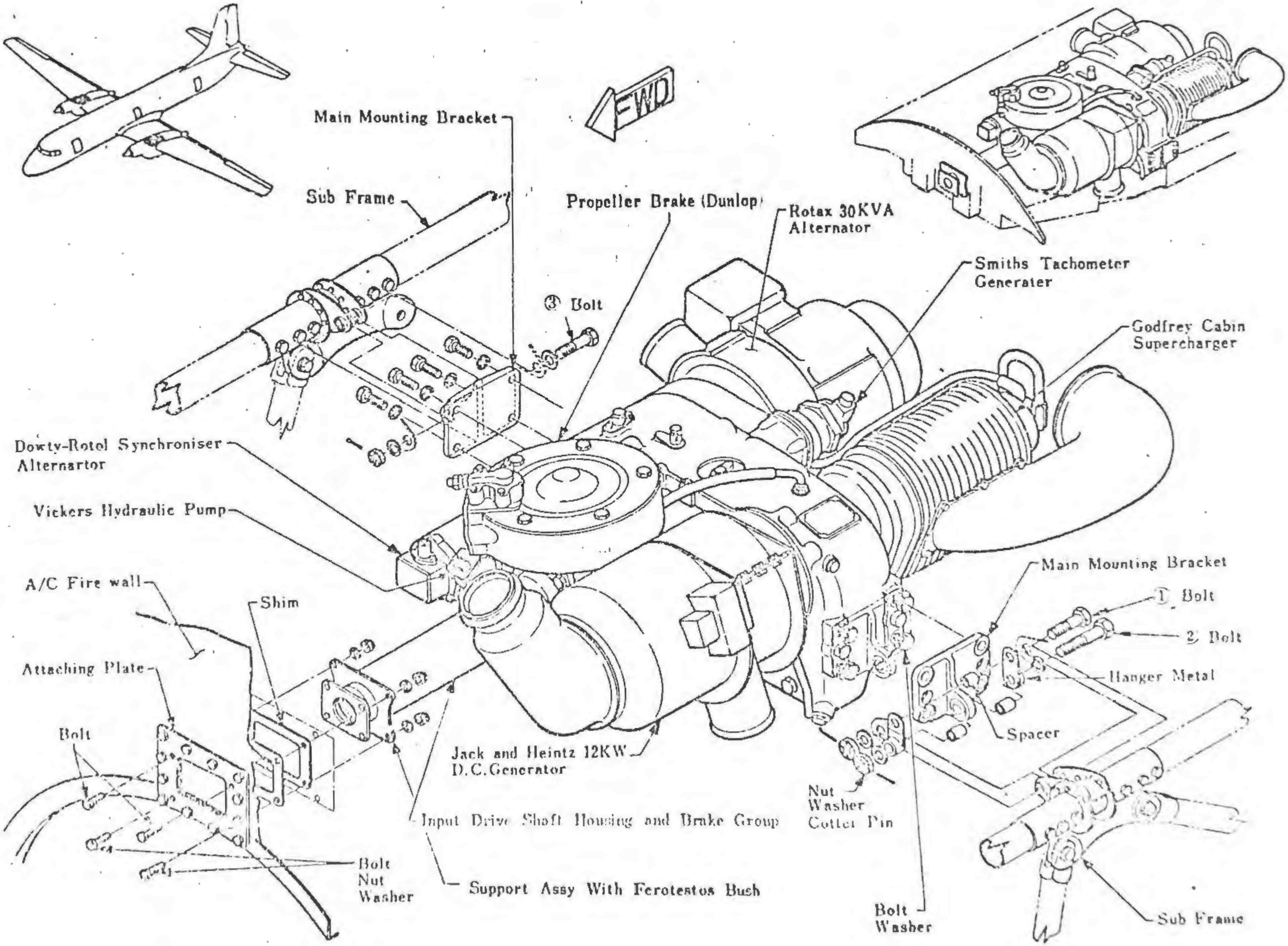
4.17.3 Gear Box Lubrication

The oil system of the gear box is an individual system consisting of oil reservoir, oil pump, filler, dipstick, and drain relief valve.
Oil quantity inside the gear box is about 5 pints. The oil level can be checked by using the dipstick through the access door made in the gear box top.
For the gear box oil system, no indicating system is installed in the cockpit.



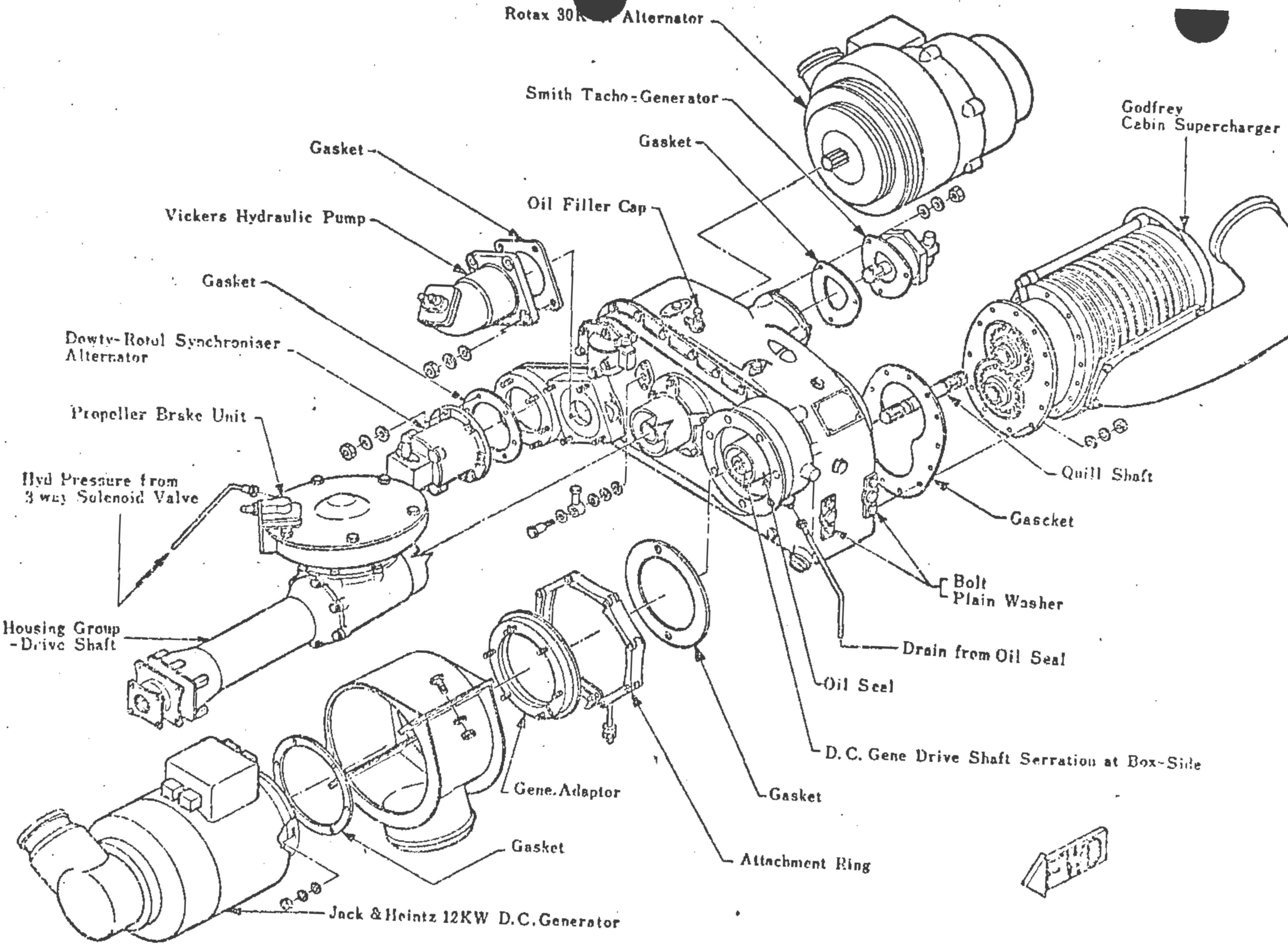
Installation of Accessory Gear Box

Fig. 4-93



Installation of Accessory Gear Box

Fig. 4-94



Accessory Gear Box Exploded View

Fig. 4-95

4.18 Fire Protection System

4.18.1 General

The engine is provided with a fire detector whereby the pilot can detect a fire; and a fire-extinguisher system; and an overheat detecting system whereby the pilot can find engine overheating.

4.18.2 Fire Detector System

The fire detector system consists of the engine firewire elements installed around the engine, warning light and warning bell.

The fire wire elements are wire elements installed throughout Zone 1 and Zone 2 of the engine and is called the fault-free fire detector. When any abnormal temperature rise is detected by these fire elements, the control unit is actuated, the fire warning light (red) in the cockpit coming on and the warning bell being rung for warnings of a fire.

Each element is of such a make that conductors are coaxially inserted in a small-diameter stainless steel tube. Between the tube inner wall and the conductors is filled a filler for insulation. Namely the filler serves as a condenser.

The electric charge accumulated in this condenser is great at a high temperature and small at a low temperature. The breakout of a fire can be detected by utilizing this property.

When an engine fire is detected, the fire warning light in the cockpit comes on and the bell rings. The warning light is provided, one each for either engine. To check to see if the system works properly, depress the top of the light. The warning bell is so designed as to be silenced when required, by means of a bell cut switch.

4.18.3 Engine Overheat Detector

To detect the overheating of the engine gear box and of the ambient structure of the engine, overheat detectors are installed on these points.

When the thermostat of the detector detects temperature rise above 180°C, the overheat warning light in the cockpit comes on.

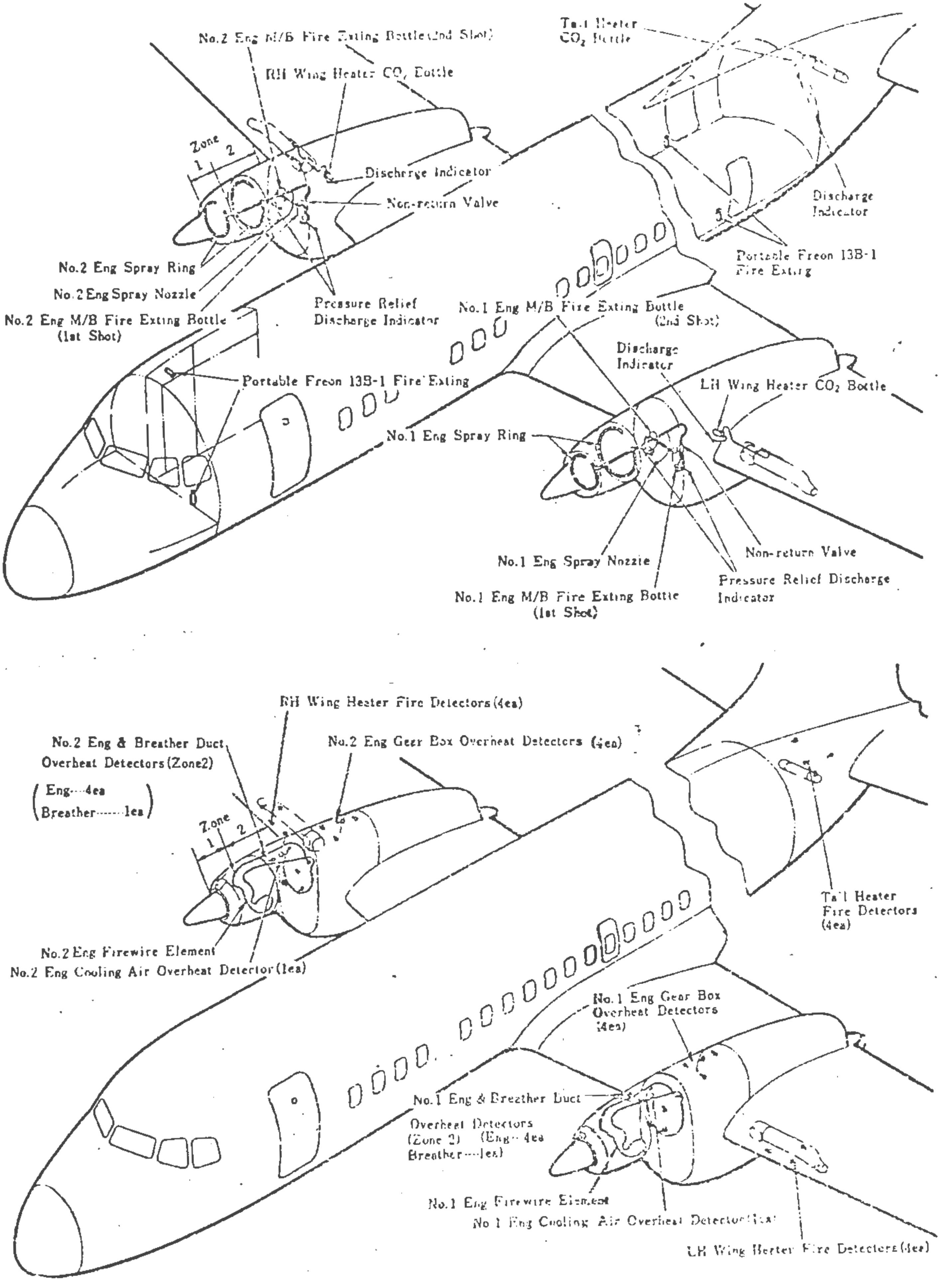
Also for indicating an abnormal rise of the engine turbine disc cooling air temperature, the cooling air overheat detector is used. When the cooling air temperature has exceeded 350°C, the detector is actuated to light the overheat warning light in the cockpit.

The overheat detectors are installed at the following 9 places:

4 places around the engine combustion chambers.
1 place at the engine breather duct.
4 places around the gear box.

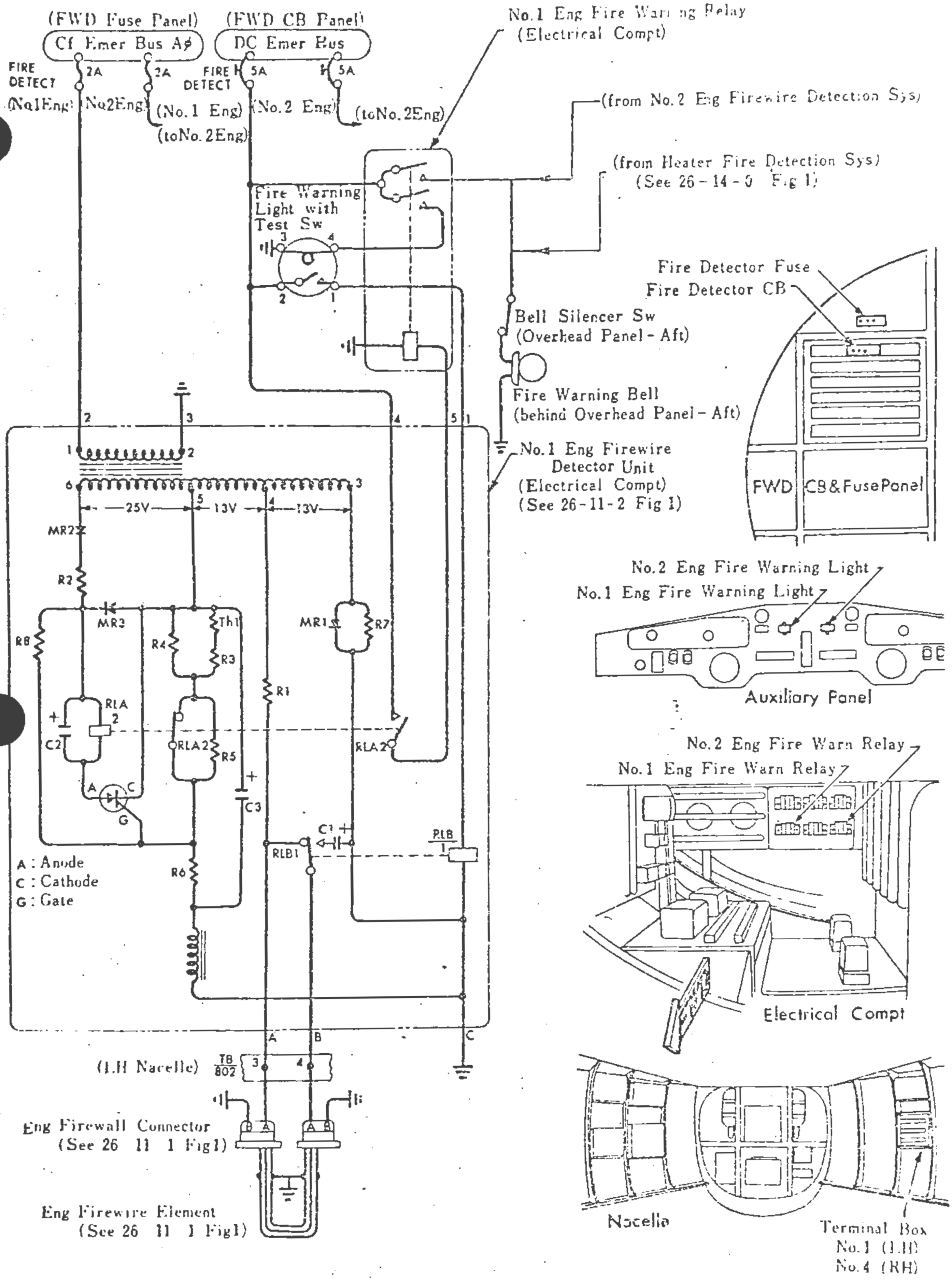
The engine overheat warning lights are provided one for each of the right- and left-hand engines, and are designed to come on in the event of engine and gear box overheat, and also of engine cooling air overheat. Therefore, it is impossible to see which of the three systems has been overheated.

To locate the overheated system, depress the top of the light and push down the overheat test switch, and the cooling air overheat detector circuit and the engine overheat detector circuit can be recognized respectively.


Tail Heater CO₂ Bottle
No.2 Eng M/B Fire Exting Bottle (2nd Shot)
RH Wing Heater CO₂ Bottle
Zone
1
2
Discharge Indicator
Non-return Valve
Discharge Indicator
Portable Freon 13B-1 Fire Exting
No.2 Eng Spray Ring
No.2 Eng Spray Nozzle
No.2 Eng M/B Fire Exting Bottle (1st Shot)
Pressure Relief Discharge Indicator
No.1 Eng M/B Fire Exting Bottle (2nd Shot)
Discharge Indicator
LH Wing Heater CO₂ Bottle
Portable Freon 13B-1 Fire Exting
No.1 Eng Spray Ring
No.1 Eng Spray Nozzle
Non-return Valve
Pressure Relief Discharge Indicator
No.1 Eng M/B Fire Exting Bottle (1st Shot)
RH Wing Heater Fire Detectors (4ea)
No.2 Eng & Breather Duct Overheat Detectors (Zone2)
(Eng----4ea
Breather------1ea)
No.2 Eng Gear Box Overheat Detectors (4ea)
Zone
1
2
No.2 Eng Firewire Element
No.2 Eng Cooling Air Overheat Detector (1ea)
Tail Heater Fire Detectors (4ea)
No.1 Eng Gear Box Overheat Detectors (4ea)
No.1 Eng & Breather Duct Overheat Detectors (Zone 2) (Eng---4ea Breather---1ea)
No.1 Eng Firewire Element
No.1 Eng Cooling Air Overheat Detector (1ea)
LH Wing Heater Fire Detectors (4ea)

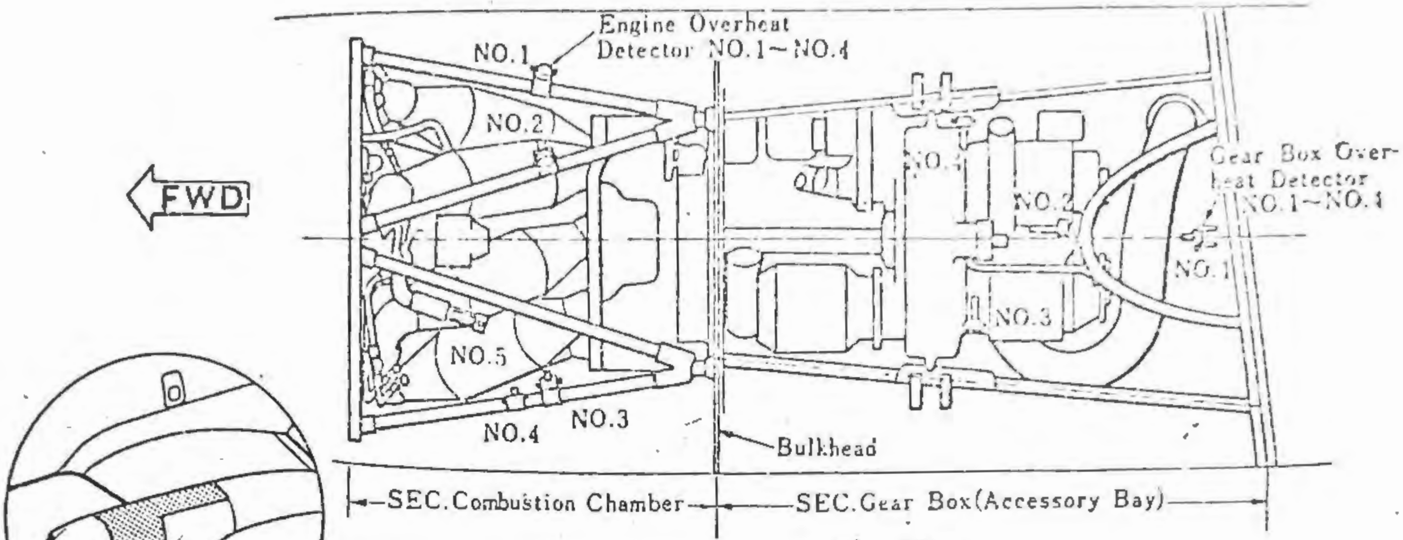
Fire Protection System Arrangement

Fig. 4-96

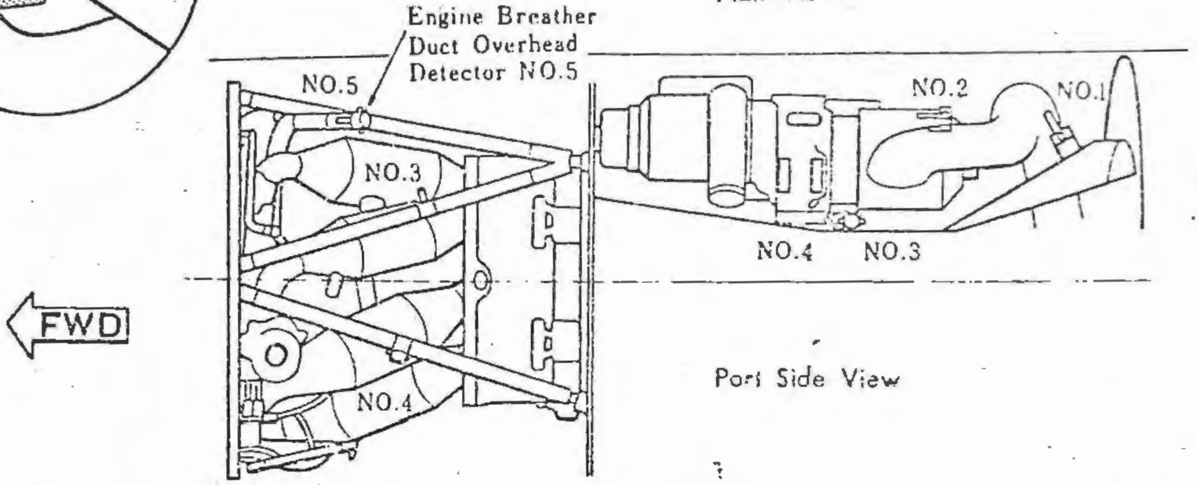


Engine Firewire System Schematic

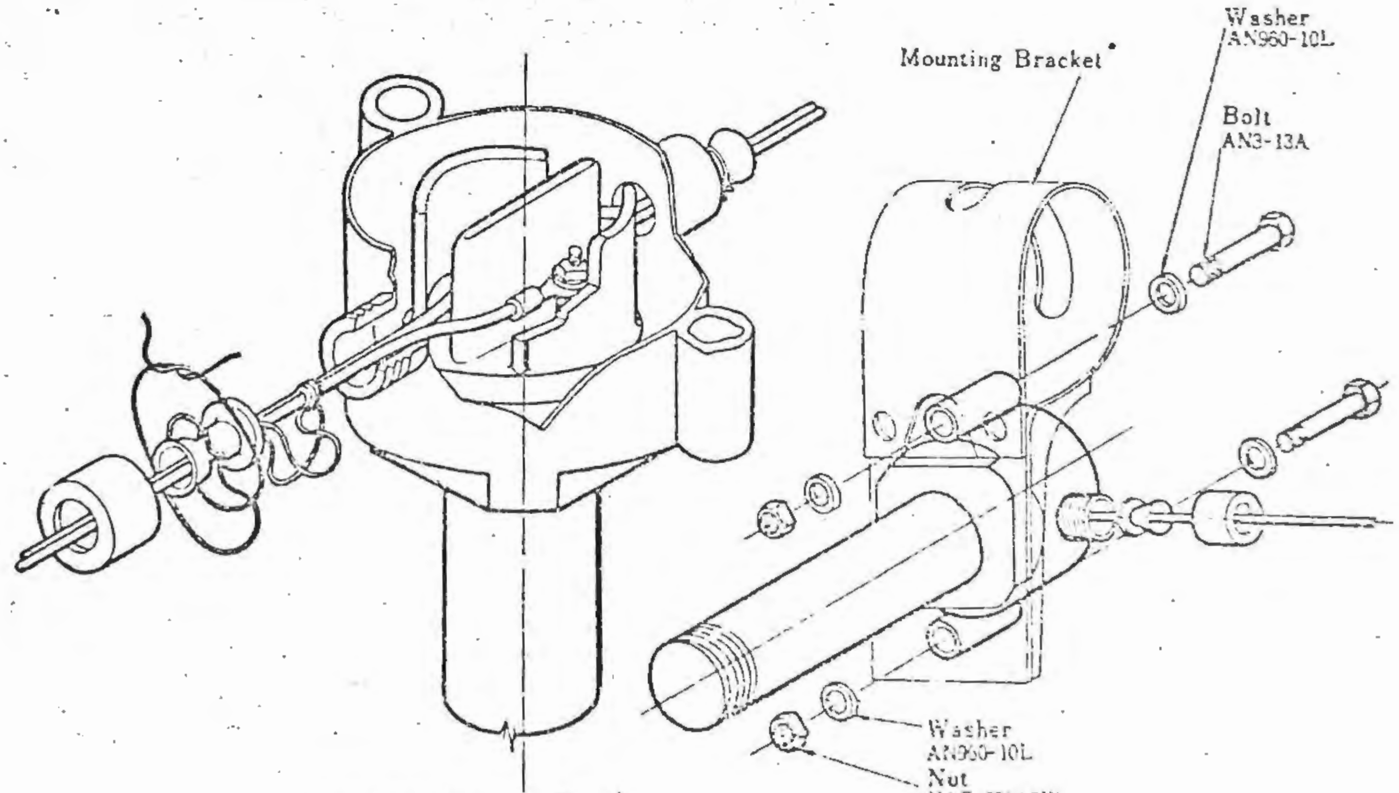
Fig. 4-98


Engine Overheat Detector NO.1~NO.4
NO.1
NO.2
NO.5
NO.4
NO.3
FWD
Gear Box Overheat Detector NO.1~NO.4
NO.4
NO.2
NO.1
NO.3
Bulkhead
SEC.Combustion Chamber
SEC.Gear Box(Accessory Bay)

Plan View



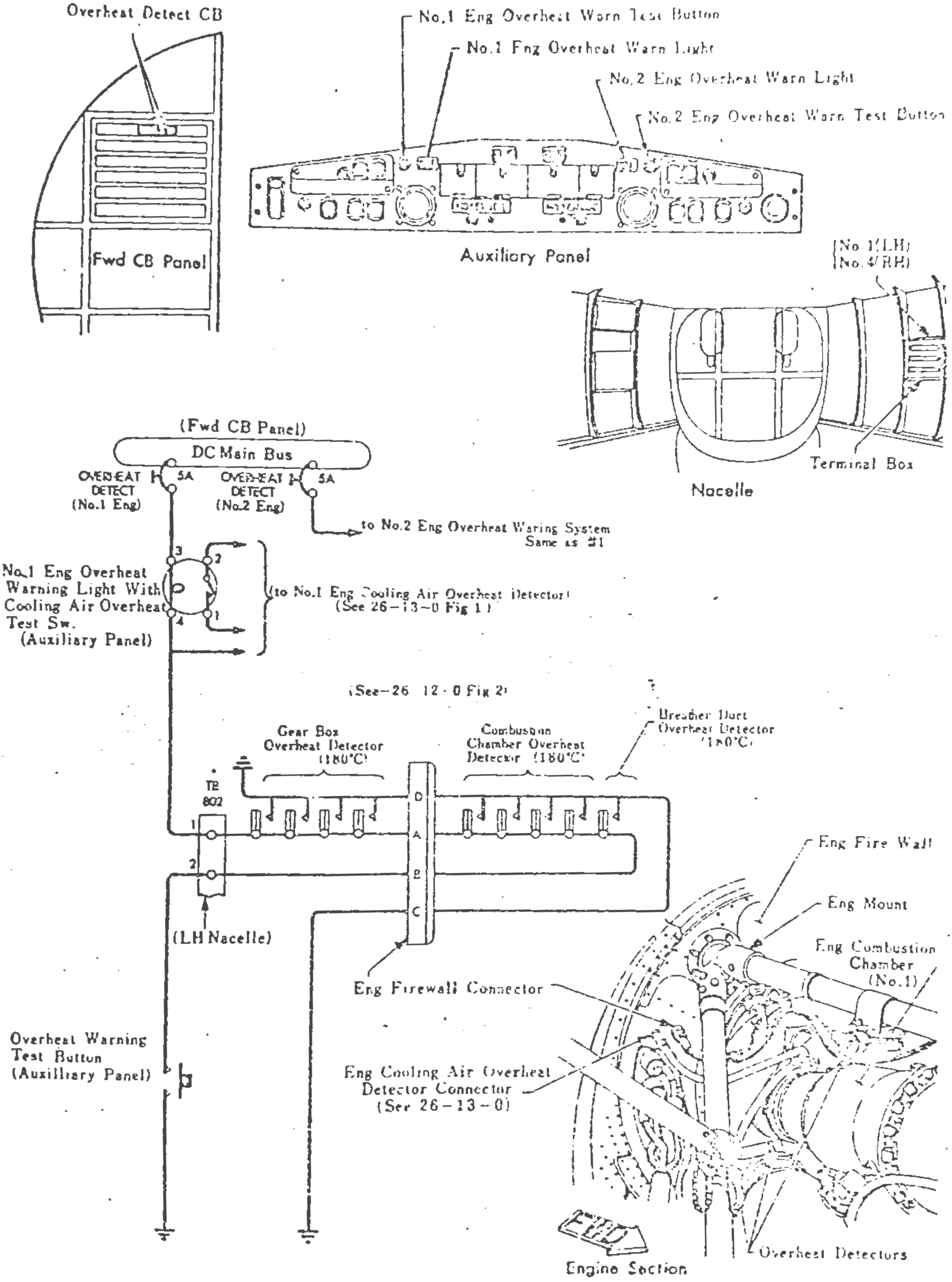
Port Side View



Overheat Detector Detail

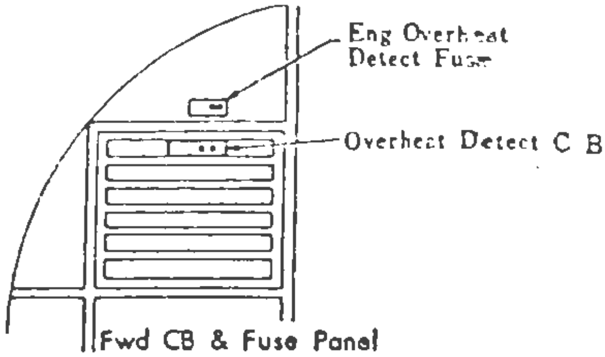
Engine Overheat Detector Installation

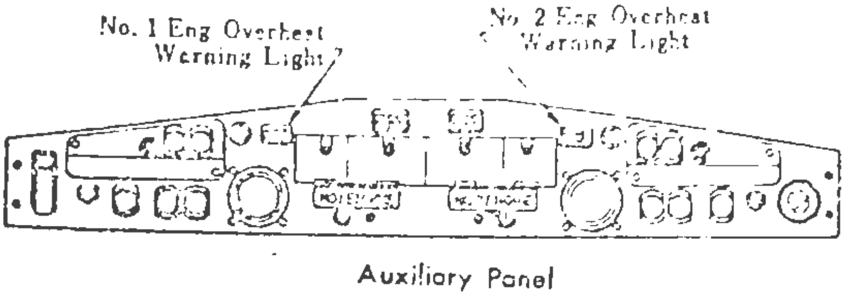
Fig. 4-99

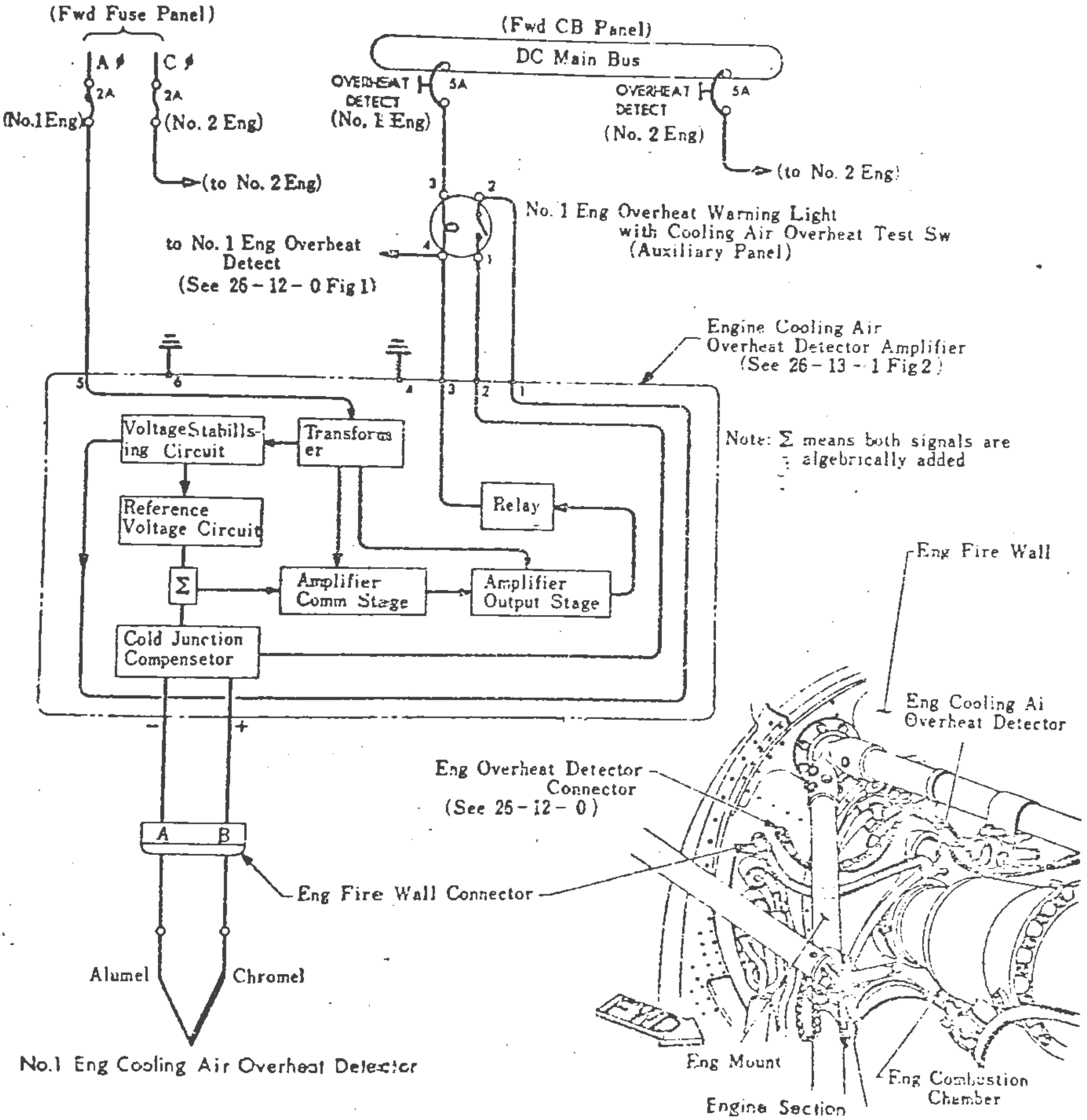

Overheat Detect CB
Fwd CB Panel
No.1 Eng Overheat Warn Test Button
No.1 Eng Overheat Warn Light
No.2 Eng Overheat Warn Light
No.2 Eng Overheat Warn Test Button
Auxiliary Panel
No.1(LH)
No.4(RH)
Terminal Box
Nacelle
(Fwd CB Panel)
DC Main Bus
OVERHEAT DETECT (No.1 Eng)
5A
OVERHEAT DETECT (No.2 Eng)
5A
to No.2 Eng Overheat Waring System Same as #1
No.1 Eng Overheat Warning Light With Cooling Air Overheat Test Sw. (Auxiliary Panel)
3
2
1
4
(to No.1 Eng Cooling Air Overheat Detector)
(See 26-13-0 Fig 1)
(See-26 12-0 Fig 2)
Gear Box Overheat Detector (180°C)
Combustion Chamber Overheat Detector (180°C)
Breather Duct Overheat Detector (180°C)
TB 802
1
2
D
A
B
C
(LH Nacelle)
Eng Firewall Connector
Overheat Warning Test Button (Auxiliary Panel)
Eng Fire Wall
Eng Mount
Eng Combustion Chamber (No.1)
Eng Cooling Air Overheat Detector Connector (See 26-13-0)
FWD
Engine Section
Overheat Detectors

Engine Overheat Warning System

Fig. 4-100




No. 1 Eng Overheat Warning Light
No. 2 Eng Overheat Warning Light
Auxiliary Panel


(Fwd Fuse Panel)
A ∮
C ∮
2A
2A
(No.1 Eng)
(No. 2 Eng)
(to No. 2 Eng)
(Fwd CB Panel)
DC Main Bus
OVERHEAT DETECT
5A
(No. 1 Eng)
OVERHEAT DETECT
5A
(No. 2 Eng)
(to No. 2 Eng)
3
2
4
1
No. 1 Eng Overheat Warning Light with Cooling Air Overheat Test Sw (Auxiliary Panel)
to No. 1 Eng Overheat Detect (See 26 - 12 - 0 Fig 1)
Engine Cooling Air Overheat Detector Amplifier (See 26 - 13 - 1 Fig 2)
5
6
4
3
2
1
Note: Σ means both signals are algebrically added
Voltage Stabilizing Circuit
Transformer
Reference Voltage Circuit
Relay
Σ
Amplifier Comm Stage
Amplifier Output Stage
Cold Junction Compensetor
-
+
A
B
Eng Fire Wall Connector
Alumel
Chromel
No.1 Eng Cooling Air Overheat Detector
Eng Fire Wall
Eng Cooling Ai Overheat Detector
Eng Overheat Detector Connector (See 26 - 12 - 0)
FWD
Eng Mount
Engine Section
Eng Combustion Chamber

Engine Cooling Air Overheat Warning System

Fig. 4-102

NOTE: The fire-extinguishing system should not be operated only when the engine overheat warning light has come on. In such a case, [illegible] the engine power and pay attention to the fire warning light. When there is any sign of overheat, feather the engines. In case of a fire warning light usually comes on in succession after the overheat warning light.

4.18.4 Fire-Extinguisher System

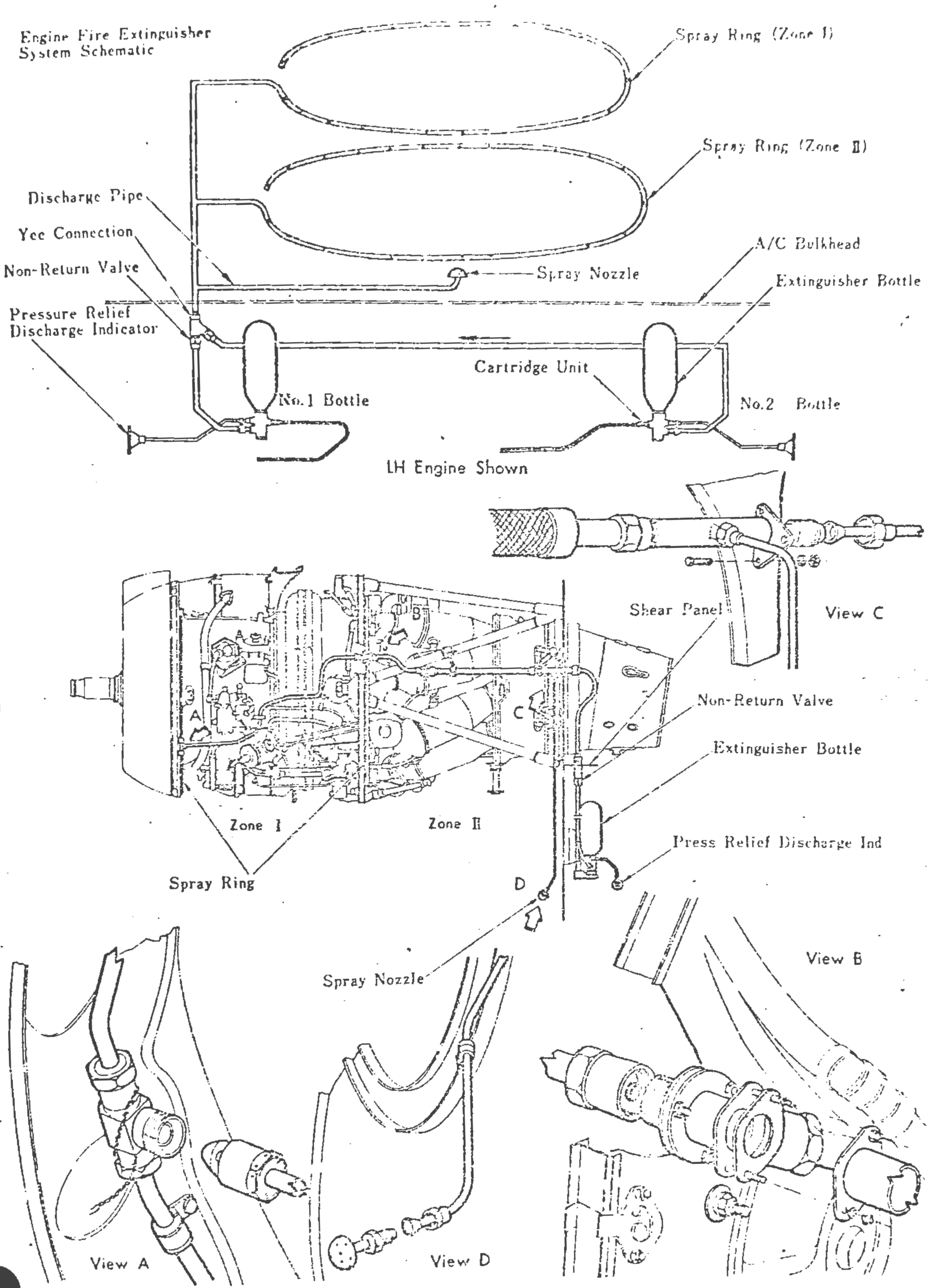
The fire-extinguisher system has methyl-bromide bottles, two for each engine independently, and is designed to discharge the agent from two spray rings and one spray nozzle installed around the engine.

In the event of fire breakout around the engine, pull the emergency shut-off handle of the engine concerned, and the fuel and hydraulic oil supply to the engine is shut off and at the same time the electrical circuit of the fire-extinguishing system is completed. Push the fire-extinguisher discharge switch down to "1 st," and one methyl-bromide bottle (L.H.) opens to discharge the agent for fire-extinguishment. If the 1st discharge of the fire-extinguishing agent was insufficient, push the discharge switch down to "2 nd," and the methyl-bromide is discharged from the other remaining bottles.

The two methyl-bromide bottles are installed at the center to the aft of the fire wall inside the nacelle.

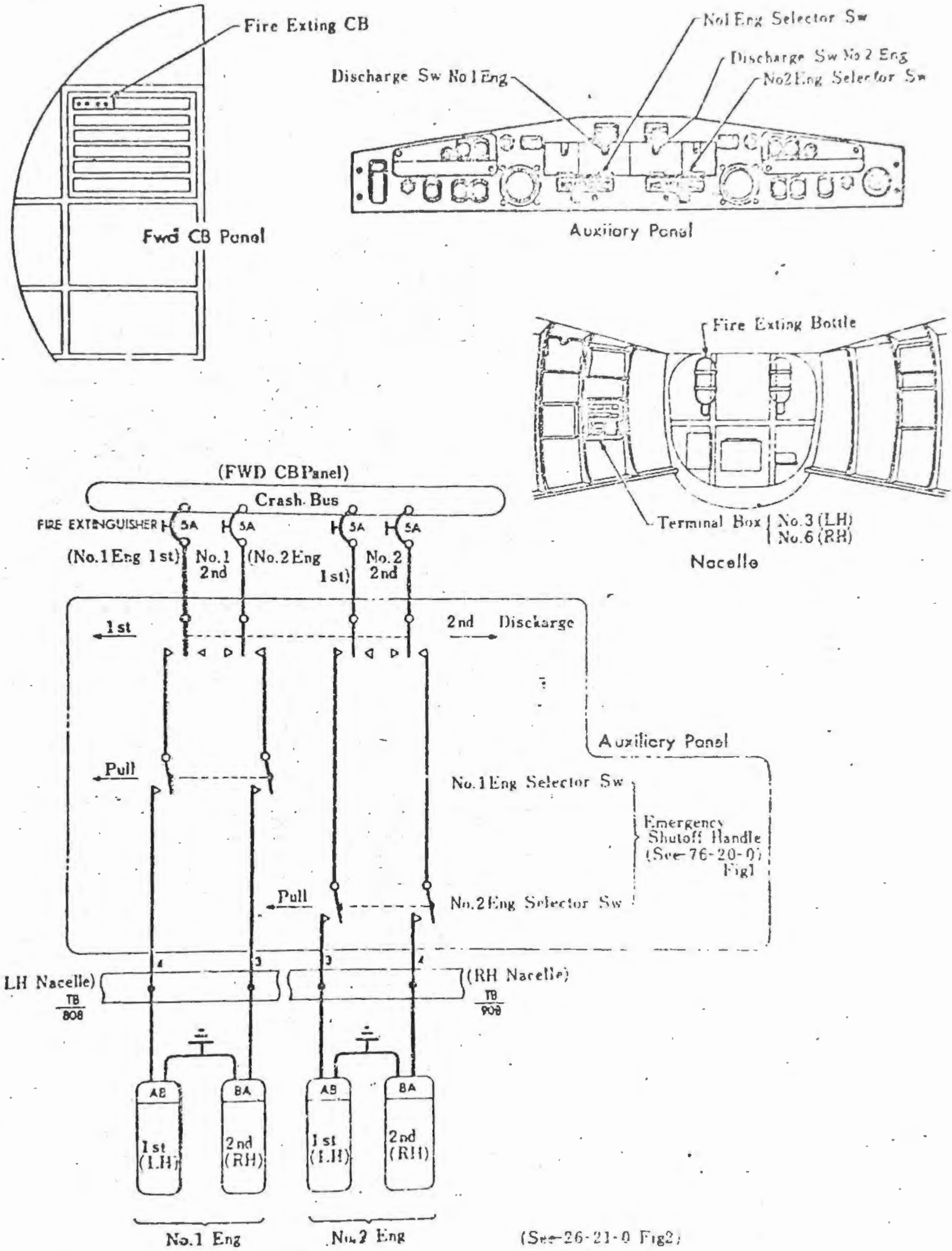
At the upper part of the bottle is fitted a cartridge unit, which, when its switch is operated, explodes the powder electrically to provide a methyl-bromide outlet and at the same time the discharge indicator pin jumps out for methyl-bromide discharge.

Where the internal pressure of the methyl-bromide bottle has increased abnormally high due to temperature rise, the pressure relief valve is operated to discharge the methyl-bromide out. In this case, the indicator disc is broken to show the red color inside.



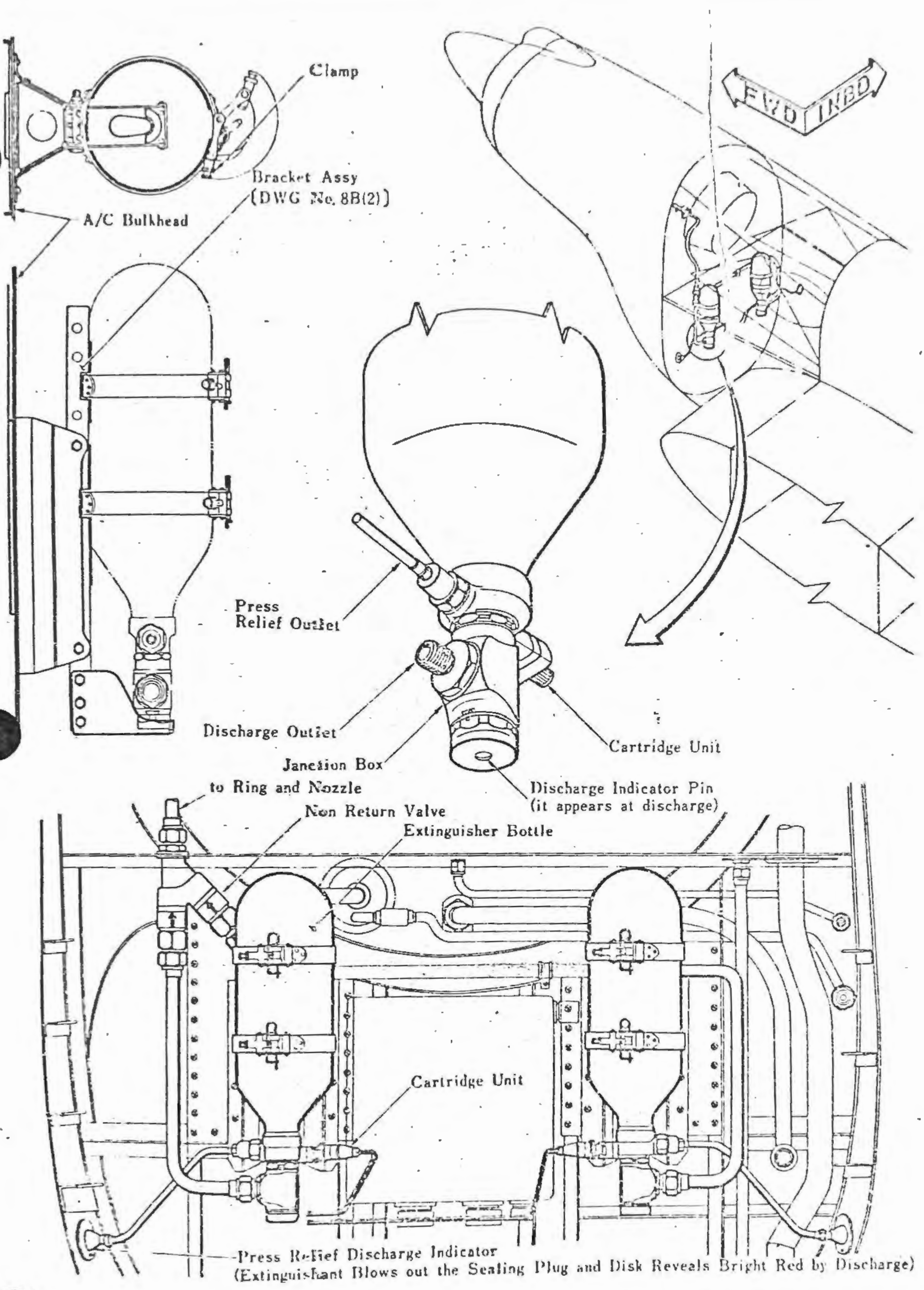
Engine Fire Extinguisher System Schematic and Spray Nozzle-Ring Installation

Fig. 4-103



Engine Fire Extinguishing System Schematic

Fig. 4-104



Bottle Indicator and Junction Box Installation

Fig. 4-105

Chapter 5 POWER PLANT - PROPELLER

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5.1 General

The airplane YS-11 is provided with Type (C) R.209/4-40-4.5/2 propellers, one for each engine. Each propeller, designed to be driven by engine power with a reduction ratio of 0.0775, is a 14 ft. 6 in.-diameter, 4-blade, non-reversing, left hand rotation, constant-speed propeller with two mechanical stops and a feather stop. The propeller pitch angle is hydraulically controllable within the range from 0° (ground fine pitch) to 84° 15' (feather position) by using the engine oil.
The propellers designed especially for the turbine engines satisfy the following requirements:

(a) Constant speed is maintained.

(b) Resistance at the time of engine start is held to a minimum for improved initial acceleration.
Further, its drag after landing for higher braking effect is great. These requirements can be fully satisfied by setting the propeller pitch angle to 0° (ground fine pitch).

(c) In order to prevent overspeeds and propeller drag due to malfunctioning of the engine, propeller, and control unit, two mechanical pitch stops are provided, whereby full operational safety can be ensured. The two mechanical pitch stops are as follows:

Low pitch stop (Flight fine pitch stop)	14°
High pitch stop (Cruise fine pitch stop)	27.5°

(d) The propeller can be feathered to reduce windmilling drag in case of engine trouble. There are two types of feathers: auto-feather and manual feather.

These propeller pitch and mechanical stop are controlled by means of the propeller control unit (P.C.U.) provided to each engine.
Besides, such devices as the de-icer, propeller brake, and propeller synchronizer are provided.

5.1.1 Principal Components

Propeller Assembly	Propeller Spinner Brush gear housing
Propeller Control Unit	
Feathering Unit	
Synchronizing Equipment	
Propeller Brake System	

5.1.2 Propeller

Four blades are supported by the double roller bearings in the propeller hub. To the fore of the hub is installed the cylinder, which is coupled with the pitch lock mechanism.

Each blade is connected to the piston inside the cylinder by means of the link mechanism. To the aft of the hub is attached the slip ring housing providing electrical power source for de-icing the propeller and spinner. A rubber overshoe with a built-in electric heater is bonded on the leading edge of each blade, covering about 40 percent of the overall length of the blade. Electric cables connect this and the slip ring housing terminal. The engine shaft has two oil tubes inside, through which the propeller cylinder and pitch lock unit operating oil is passed.

5.1.3 Spinner

The spinner, housing both the propeller cylinder and hub, is attached with pins on the propeller slip ring housing. This spinner serves, together with the air intake casing of the engine, to streamline airflow into the engine.
The electric heater is installed inside the nose of the spinner.

5.1.4 Brush Gear Housing

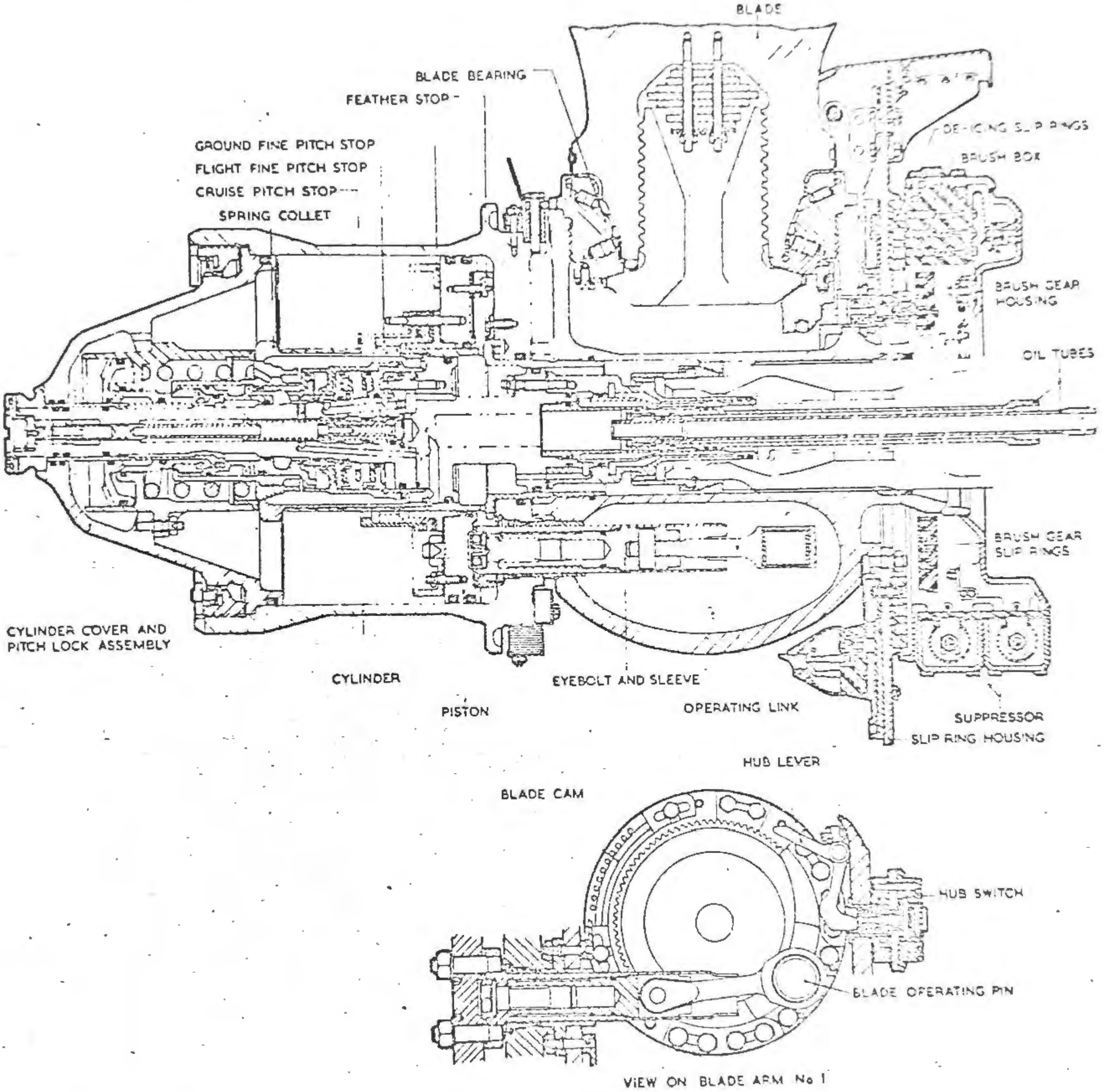
The brush gear housing is fixed on the engine side; and accordingly it does not rotate with the propeller. It has two brush box assemblies in contact with the three slip rings built in the propeller slip ring housing. The electrical wiring harness is connected to this brush box to supply electrical power for de-icing to both the propeller and the spinner.
Inside the housing are installed five slip rings, whereby the electrical wiring harness on the fuselage and the propeller control system are connected. In the propeller hub are provided three switches (hub SW), which come into contact with these brush gear slip rings when the propeller blades are set to a prescribed pitch, forming an electric circuit for propeller control.

5.1.5 Propeller Control Unit (P.C.U.)

The propeller control unit consists of a gear type oil pump and a centrifugal governor driven by the engine reduction gear. The oil pump increases the pressure of the oil coming from the engine and sends it to the propeller cylinder and pitch lock. The governor controls the movement of the piston valve through which the oil is led to the propeller.

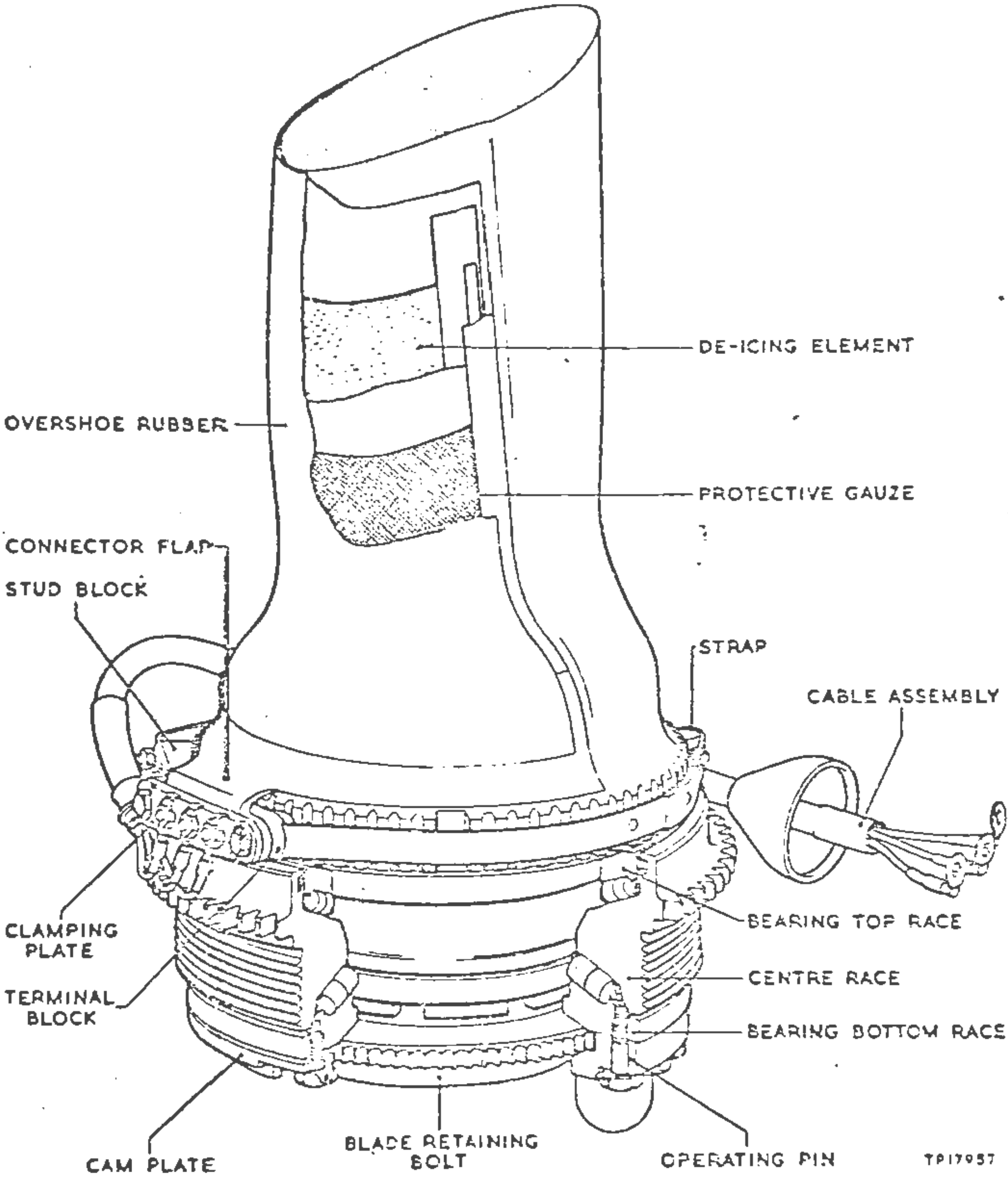
5.1.6 Feathering Unit

The feathering unit is composed of an oil pump driven by an electric motor, that is, a feathering pump which boosts up the pressure of the oil from the engine tank, feeding the pressured oil into the propeller control unit in place of the normal system when required for feathering or other purposes. The electric motor, which operates on the 24-volt direct-current power, can develop an output of about 2.75HP. Avoid continuous operation of the feather pump in excess of 3 minutes at one time.



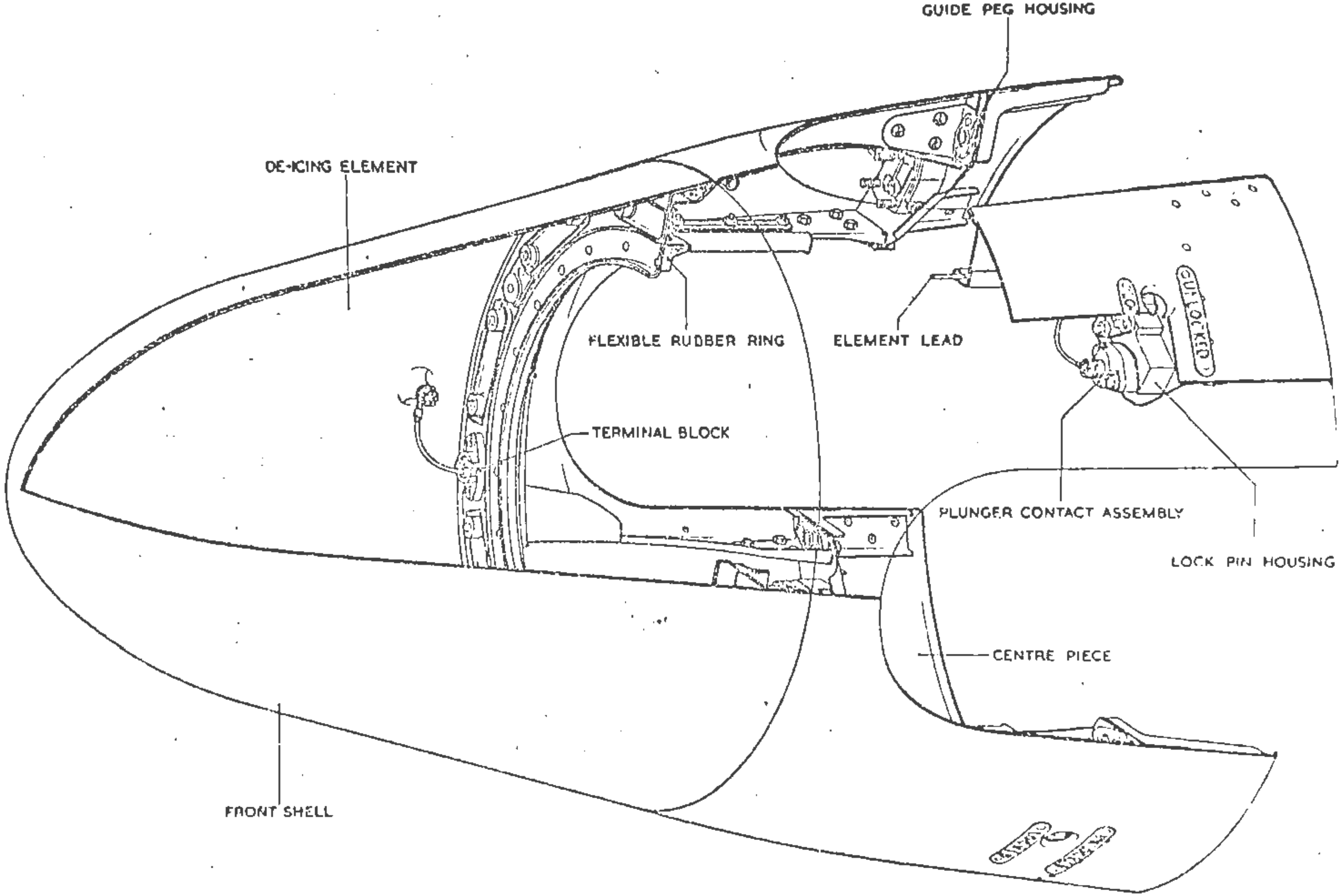
GENERAL ARRANGEMENT OF PROPELLER
(TYPE (c) R.209/4-40-4.5/2)

Fig. 5-2



BLADE DETAILS

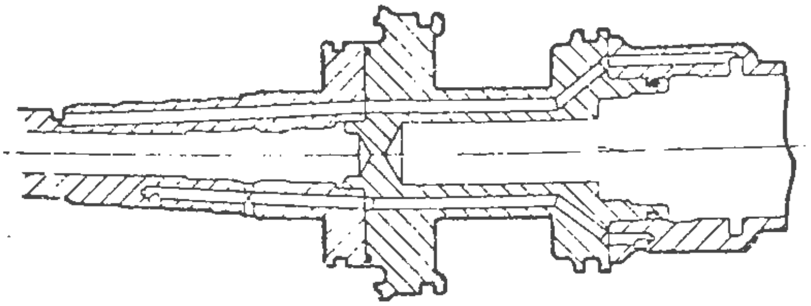
Fig. 5-3



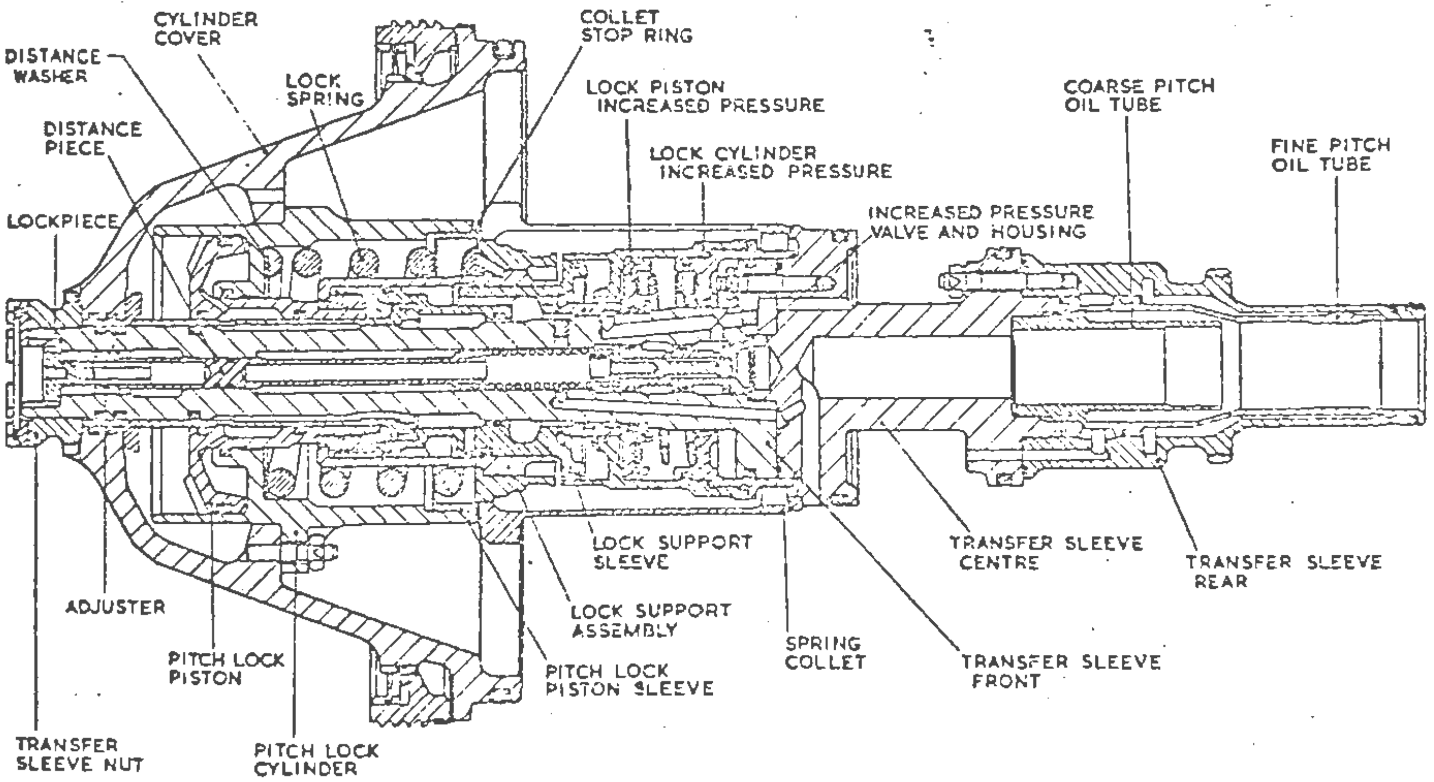
SECTIONED SPINNER

Fig. 5-4

SECTION THROUGH PITCH LOCK SHOWING THIRD OIL LINE PASSAGES

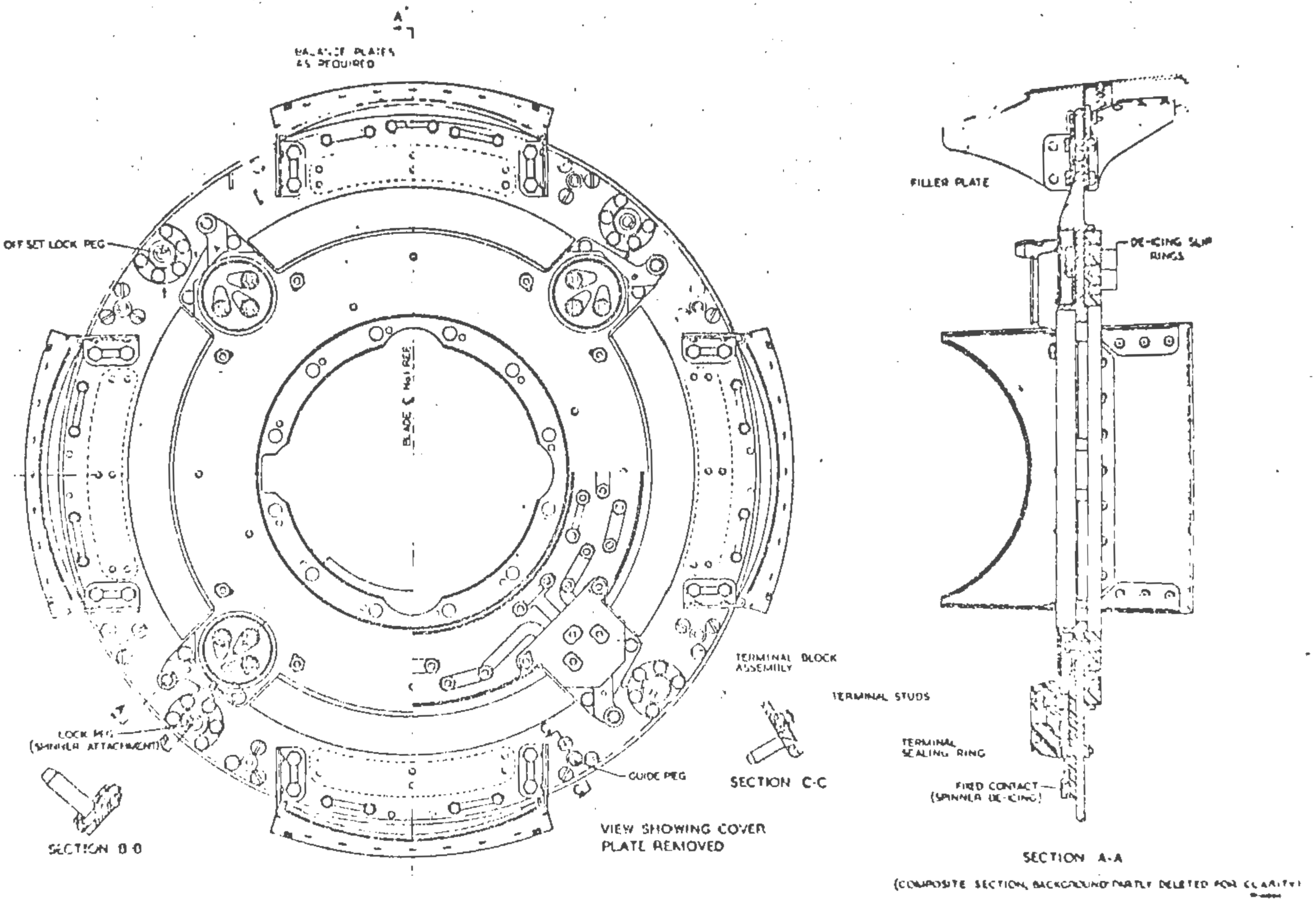


SECTION SHOWING DRAIN OIL PASSAGES



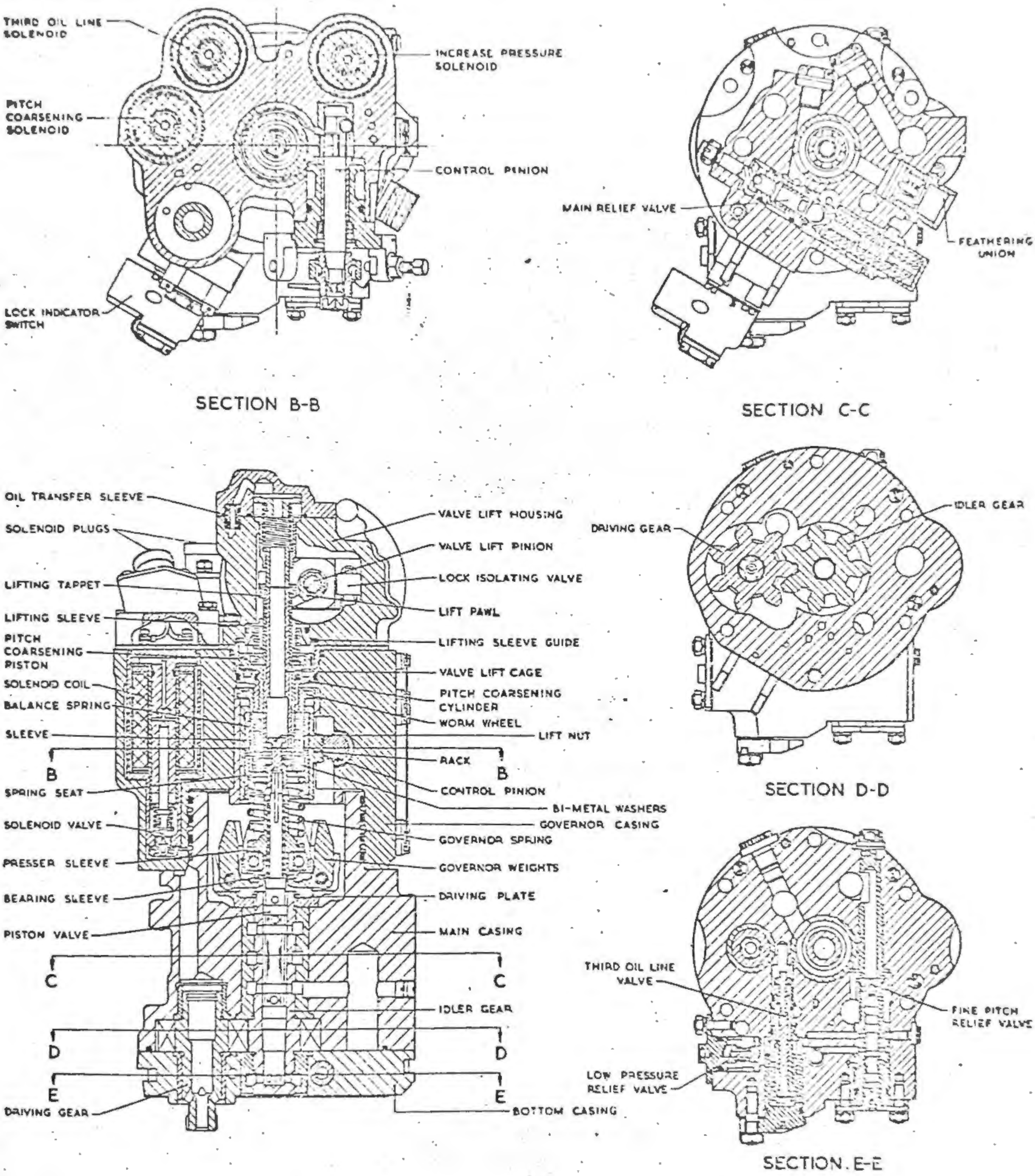
PITCH LOCK ASSEMBLY

Fig. 5-5



SLIP RING HOUSING

Fig. 5-7



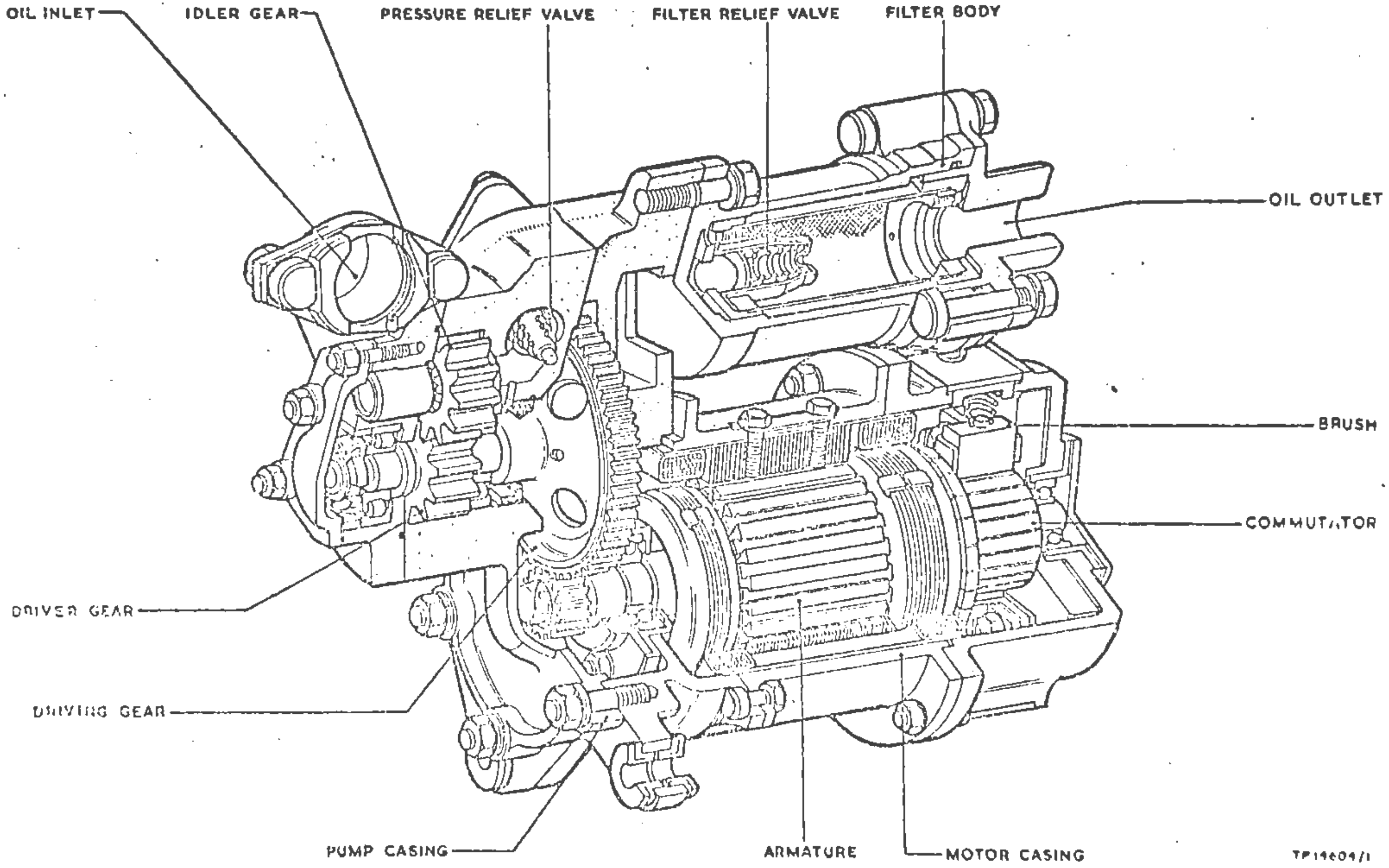
SECTION B-B

SECTION C-C

SECTION D-D

SECTION E-E

SECTIONED VIEW OF CONTROLLER UNIT (NON-REVERSING)
Fig. 5-8



FEATHERING UNIT TYPE (c) RTP/26
Fig. 5-9

5.2 Pitch Control

5.2.1 General

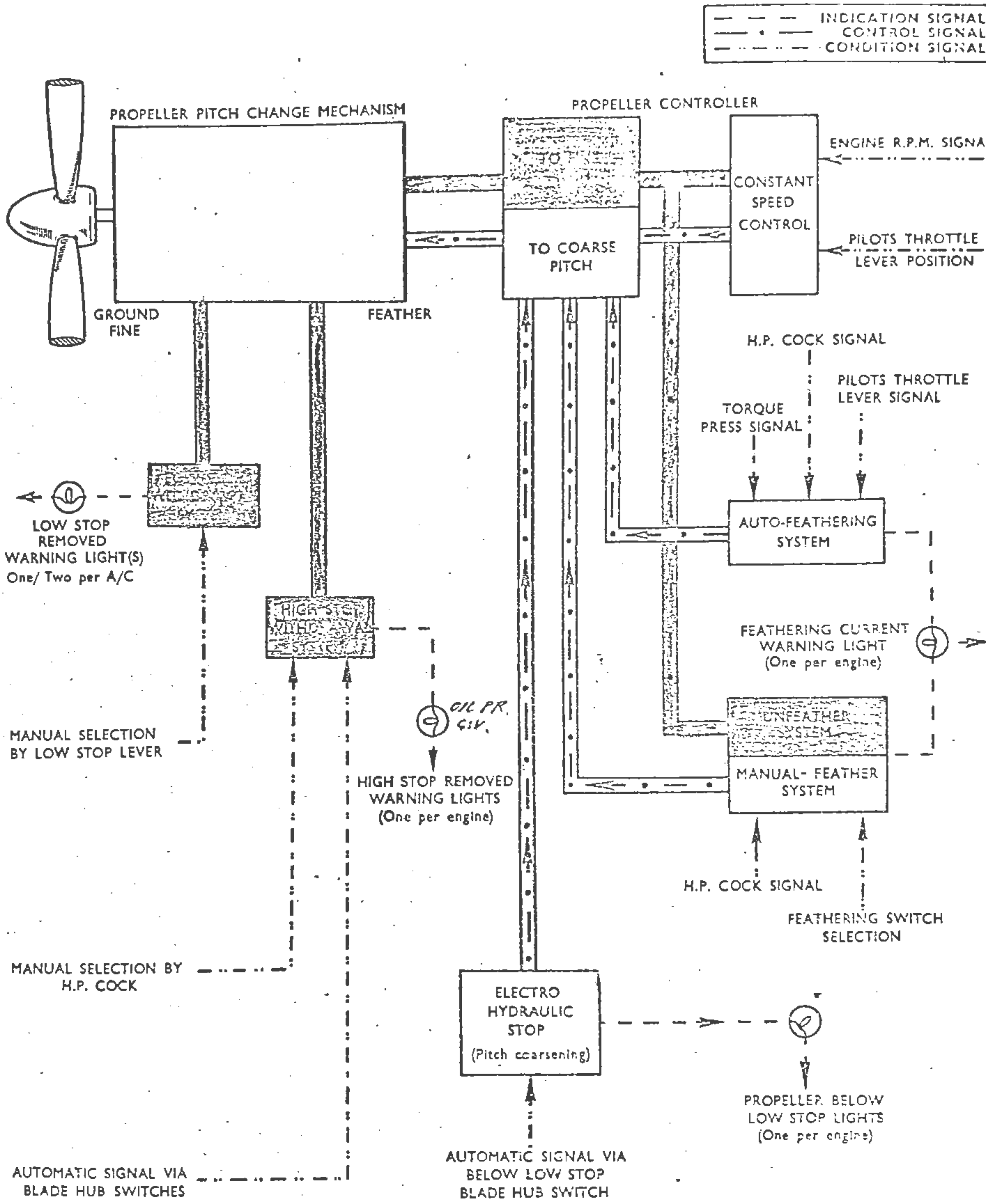
The propeller blade pitch angle is controllable from 0° (ground fine pitch) to 84°15' (feather position). The propeller pitch changing mechanism is designed to be operated hydraulically, i.e., by moving the piston inside the propeller cylinder by the engine oil pressured from 70 psi up to the maximum 760 psi by means of the oil pump. Since the piston is coupled to the root of the blade, the movement of the piston varies the blade pitch angle. Piston movement is controlled hydraulically by the propeller control unit. The hydraulic pressure applied to the front end of the piston increases the pitch (Coarsen) while that applied to the rear end of the piston decreases the pitch (Fine-off).

5.2.2 Constant Speed Control

The constant speed ranges from the minimum 11,000 rpm to the maximum 15,000 rpm any desired constant speed can be selected within this range simply by setting the throttle lever to the desired position. To prevent overspeed running, the engine fuel pump is provided with an overspeed governor, whereby the fuel flow is regulated automatically to slow down the engine speeds below 16,500 rpm in case the maximum speed is exceeded.
In the event that the engine speed thus selected by the throttle lever is changed, P.C.U. works automatically to control it. Namely, in case that speed variation takes place, the piston valve of P.C.U. which is balanced by both the centrifugal force acting upon the constant speed governor weight inside P.C.U. and the spring load to be determined by the throttle position, is operated to control the oil flow into the piston. When the engine speed exceeds the speed set by the throttle lever, the centrifugal force of the governor weight overcomes the spring load, pulling upward the piston valve to allow the hydraulic fluid from the P.C.U. pump to flow into the Coarsen side. Thus the pitch can be increased to lower the speed to the initial rate. On the contrary, when the engine speed has decreased below the set rate, the spring load overcomes the centrifugal force of the governor weight, the piston valve moving down to permit the flow of the hydraulic fluid into the Fine side to decrease the pitch angle, raising the engine speed to the initial rate. The hydraulic pressure flowing to the Fine side is controlled to 230 psi by means of the fine pitch relief valve.
When the spring load and the governor weight centrifugal force are balanced, the piston valve is in the neutral position, passing no hydraulic pressure to either the Coarsen or Fine side. And the propeller maintains a constant speed and a constant pitch.
The minimum load of the governor spring has been preset, the engine speed being 11,000 rpm. Accordingly this speed is called the minimum constant speed, below which the propeller can not maintain a constant speed.
Move the throttle lever from the minimum position, and at about 35% of the full stroke of the throttle lever, the minimum constant speed is reached.

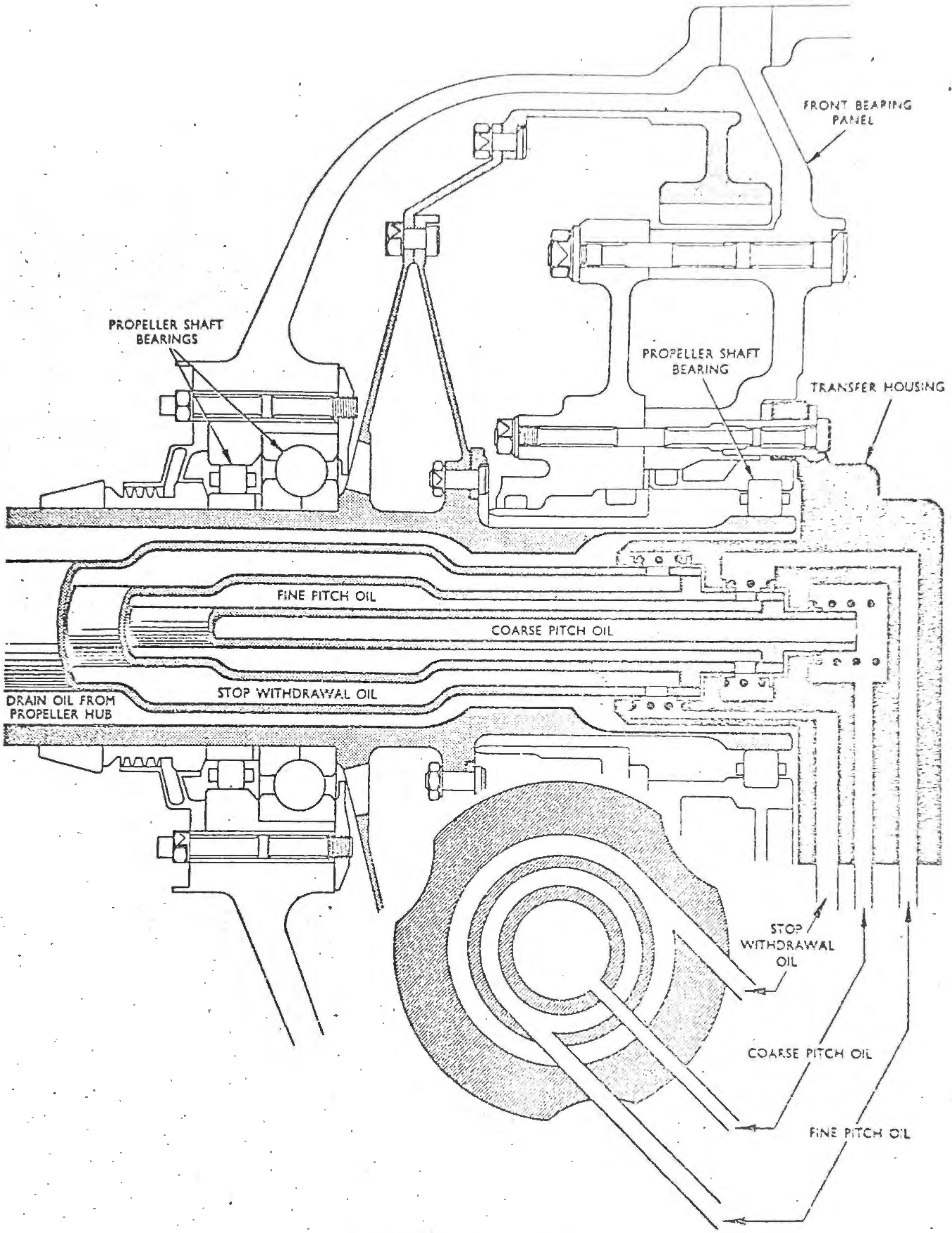
5.2.3 Ground Fine Pitch

The ground fine pitch is 0°, below which the propeller pitch will never go down. This pitch is used on the ground to facilitate initial acceleration by decreasing propeller resistance at the time of engine start and also to obtain a greater drag so that higher braking efficiency after landing can be ensured.


INDICATION SIGNAL
CONTROL SIGNAL
CONDITION SIGNAL
PROPELLER PITCH CHANGE MECHANISM
PROPELLER CONTROLLER
TO
TO COARSE PITCH
CONSTANT SPEED CONTROL
ENGINE R.P.M. SIGNA
PILOTS THROTTLE LEVER POSITION
GROUND FINE
FEATHER
H.P. COCK SIGNAL
PILOTS THROTTLE LEVER SIGNAL
TORQUE PRESS SIGNAL
AUTO-FEATHERING SYSTEM
LOW STOP REMOVED WARNING LIGHT(S)
One/ Two per A/C
HIGH STOP WITHDRAWAL SYSTEM
FEATHERING CURRENT WARNING LIGHT
(One per engine)
OIL PR. SW.
UNFEATHER SYSTEM
MANUAL- FEATHER SYSTEM
MANUAL SELECTION BY LOW STOP LEVER
HIGH STOP REMOVED WARNING LIGHTS
(One per engine)
H.P. COCK SIGNAL
FEATHERING SWITCH SELECTION
MANUAL SELECTION BY H.P. COCK
ELECTRO HYDRAULIC STOP
(Pitch coarsening)
PROPELLER BELOW LOW STOP LIGHTS
(One per engine)
AUTOMATIC SIGNAL VIA BLADE HUB SWITCHES
AUTOMATIC SIGNAL VIA BELOW LOW STOP BLADE HUB SWITCH

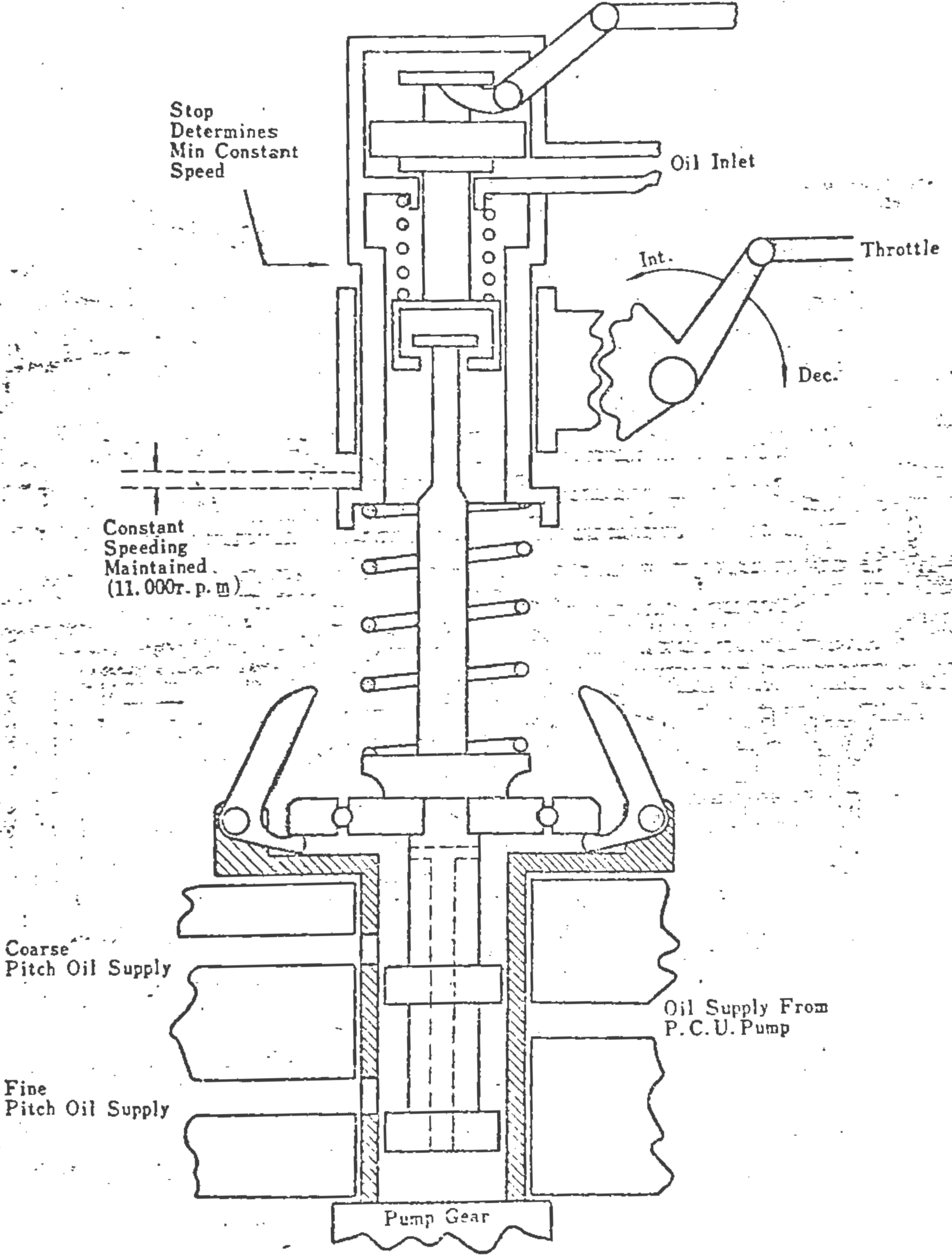
DART PROPELLER SYSTEM BASIC PRESENTATION

Fig. 5-10



PROPELLER OIL FEED

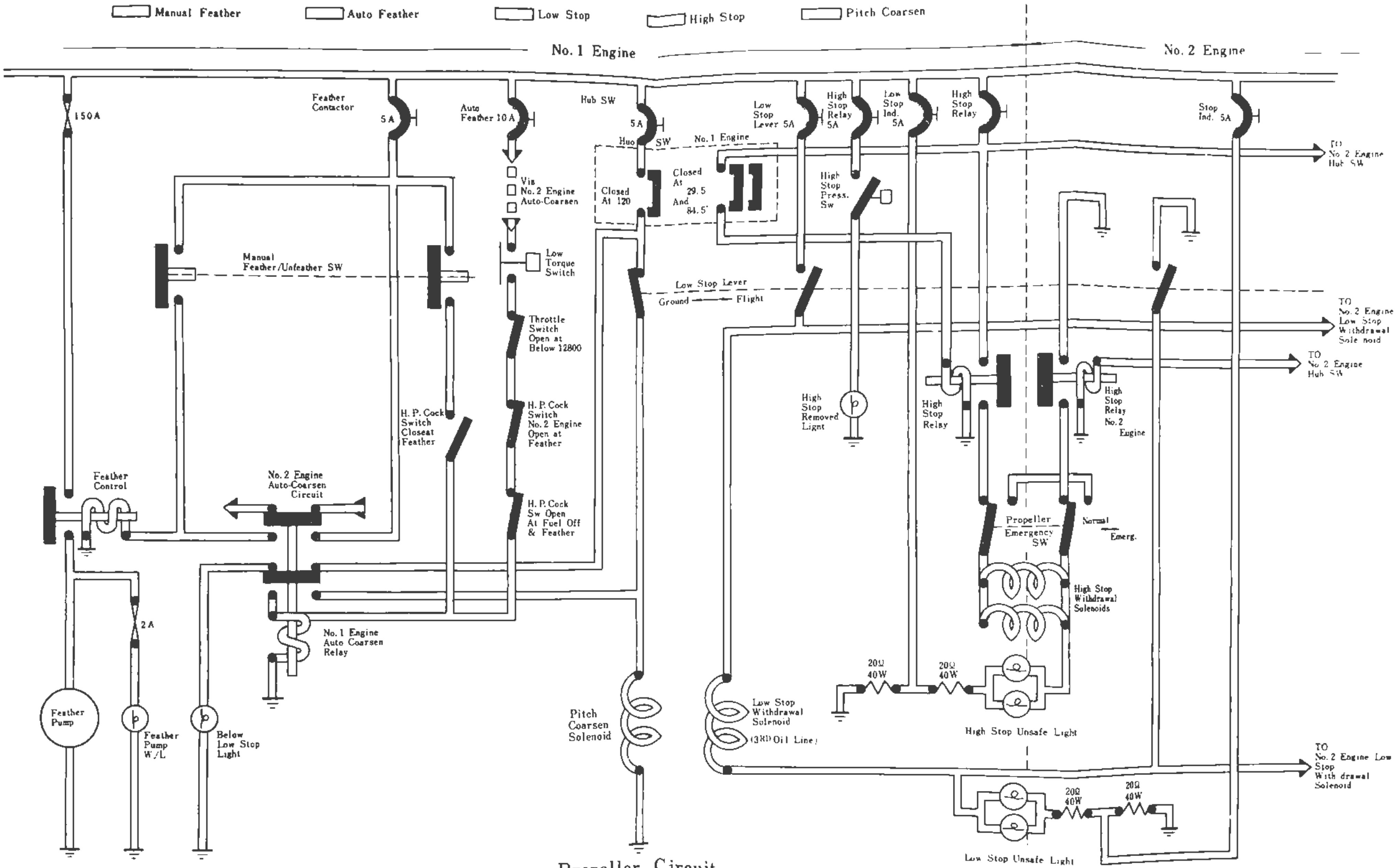
Fig. 5-12



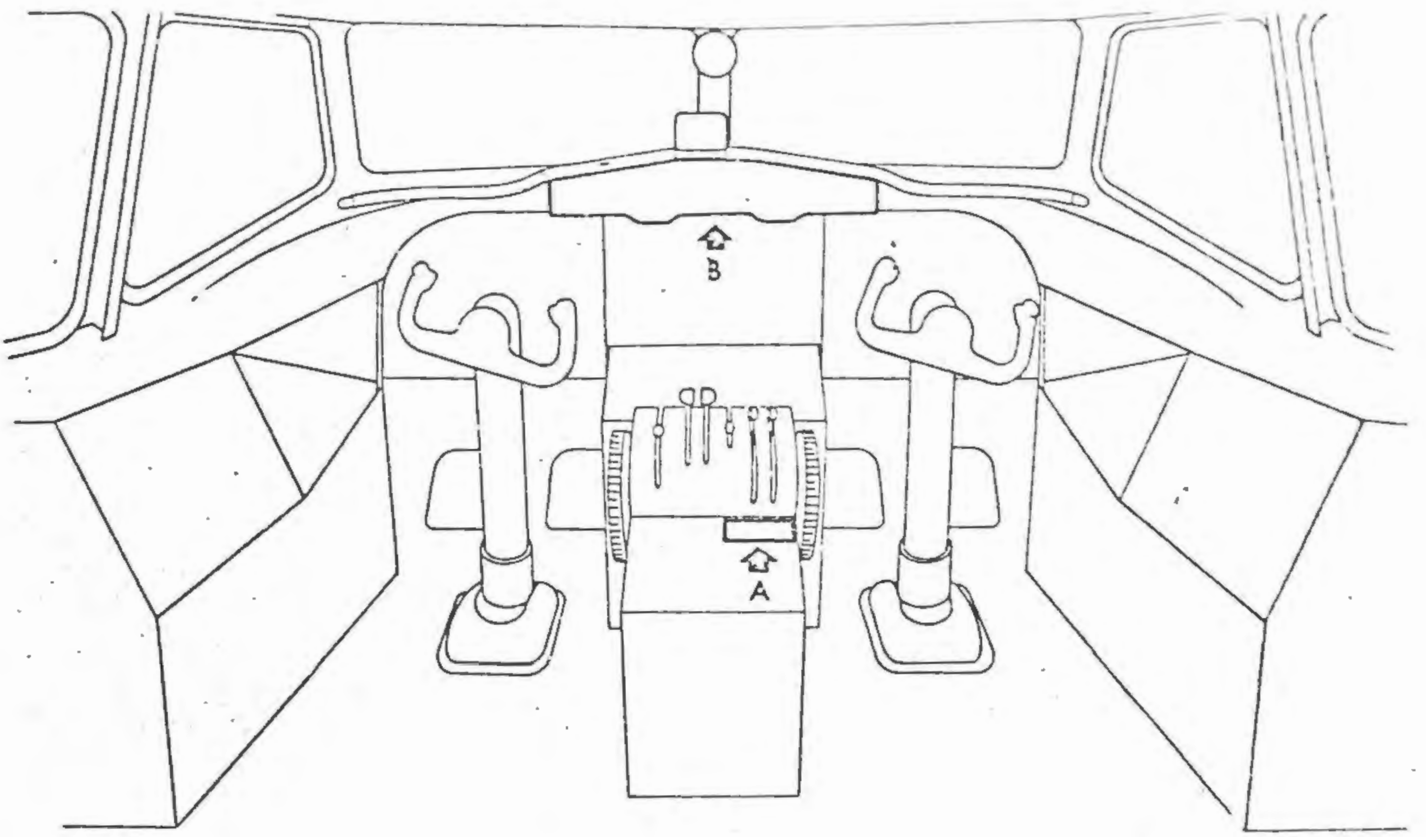
P.C.U. R.P.M. Selection

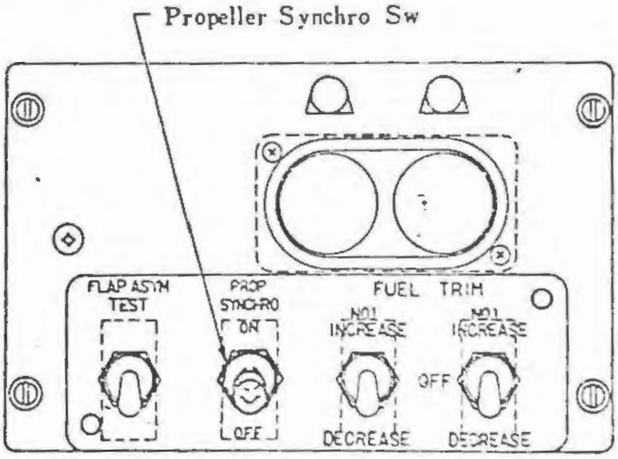
Fig 5 — 13

June /66

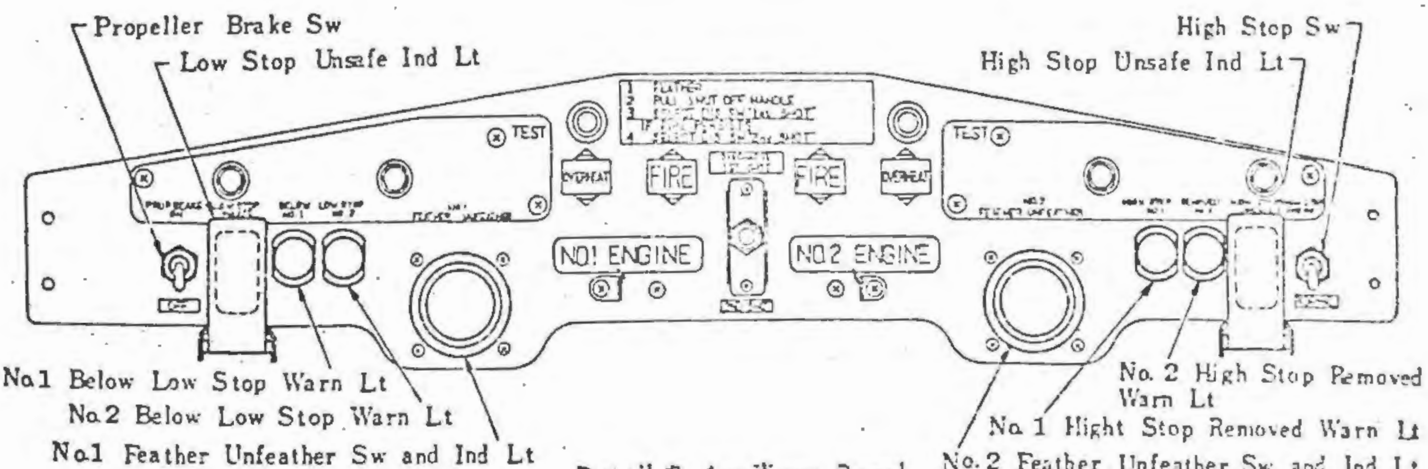


Propeller Circuit
Fig 5 — 15





Detail A Pedestal


Propeller Brake Sw
Low Stop Unsafe Ind Lt
High Stop Sw
High Stop Unsafe Ind Lt
TEST
OVERHEAT
FIRE
FIRE
OVERHEAT
TEST
NO1 ENGINE
NO2 ENGINE
No.1 Below Low Stop Warn Lt
No.2 Below Low Stop Warn Lt
No.1 Feather Unfeather Sw and Ind Lt
No. 2 High Stop Removed Warn Lt
No. 1 Hight Stop Removed Warn Lt
No. 2 Feather Unfeather Sw and Ind Lt

Detail B Auxiliary Panel

Propeller Control

Fig. 5-17

As the centrifugal force of the P.C.U. governor weight is less than the spring force at an engine speed below the minimum constant speed, the piston valve goes down and the hydraulic pressure is invariably being applied to the Fine side; and accordingly the pitch angle remains at 0° when the engine speed is below 11,000 rpm.

5.2.4 Propeller Pitch Stop

For the purpose of satisfying all requirements of the propeller for the turbine engine, the propeller is provided with two mechanical pitch stops: High Stop (cruise fine pitch stop) for 27.5° of pitch angle and Low Stop (flight fine pitch stop) for 14° of pitch angle. These mechanical stops prevent the increase of drag caused by the decrease of pitch below the prescribed angle of the stop when the propeller windmills for some reason or other at the time of take-off or low-speed operation, or during cruising. These pitch stops are not formed when the blade is below the prescribed angle, but are formed only when pitch coarsening proceeds until the blade exceeds the angle. When there is a need of decreasing the propeller pitch to a smaller angle than the stop, the pitch lock mechanism is operated automatically or manually to withdraw the pitch lock.
Low stop shall be kept formed during flight and shall not be withdrawn. Accordingly the low stop is so designed as to be withdrawn manually only at the pilot's will.
The pitch lock mechanism is operated hydraulically, and is controlled electrically by means of the lock withdrawal solenoids in P.C.U.

5.3 Pitch Stop Mechanism

5.3.1 General

Fundamentally, the pitch stop mechanism consists of a spring collet protruding into the propeller piston stroke. The spring collet is so designed as to be pushed into the piston when the propeller pitch angle is decreased. To lock the stop to prevent the propeller pitch from decreasing, the three-stage spring load support is moved into the spring collet to limit the inward movement of the spring collet.
The three stages of the support are as follows.

Unlock	Both stops.
Lock	Low stop.
Lock	High stop.

To withdraw the lock to release the stop, push the lock support by moving the lock operating cylinder with the hydraulic pressure against the spring load, automatically by means of the solenoid of P.C.U. or manually through a mechanical system.

5.3.2 High Stop (Cruise Fine Pitch Stop)

The high stop is a mechanical pitch stop set at 27.5°. Should the propeller windmill during cruising for some reason or other and the propeller pitch be decreased, the drag might grow extremely great to cause a danger. To prevent this trouble, this stop is located slightly lower than the propeller pitch angle for cruising so that the propeller pitch will never be

5.3.2.5 Manual Withdrawal

When the pilot wants to fine one propeller below the high stop while holding the other propeller at the high stop by the propeller emergency switch, or when the high stop will not be withdrawn automatically due to a trouble with the automatic withdrawal circuit, the high stop can be withdrawn manually by shifting the H.P. cock lever to "LOCK OUT" position. When the H.P. cock lever is placed in "LOCK OUT" position, the solenoid isolating valve of P.C.U. is operated to permit the flow of pressure oil to the fine pitch relief valve by by-passing the normal solenoid system, the high stop being withdrawn.
In this case, the high stop remove light comes on to indicate that the high stop is in the withdrawn position.

5.3.3 Low Stop (Flight Fine Pitch Stop)

This low stop is a mechanical pitch stop set at the pitch angle of 14°.
In flight, the propeller pitch will never be decreased below this angle, so that excess drag is prevented.
Accordingly this stop is designed to be controlled manually only on the ground.

5.3.3.1 Low Stop Lever

The low stop of each propeller is operated by one low stop lever located at the pedestal in the cockpit. The low stop lever has two positions - "FLIGHT" and "GROUND." In "FLIGHT" position, the low stop is formed, while in "GROUND" position, the low stop is withdrawn.
The low stop lever is mechanically connected to the throttle lever. Place the both throttles in MAX., and "FLIGHT" is automatically selected.
When the gust lock is in ON position, the low stop lever can not be placed in "FLIGHT." (Refer to Para. 4.13.5.)
Place the slow stop lever in "GROUND," and the low stop withdrawal solenoid circuit is completed and the solenoid valve is energized to open the 3rd oil line valve to pass the oil into the 3rd oil line of the pitch lock unit, the slow stop being withdrawn. For safety, the oil supplied from the low stop withdrawal solenoid flows through the high stop withdrawal solenoid, whereby the low stop can be withdrawn only after the withdrawal of the high stop.

5.3.3.2 Electro-Hydraulic Stop

Should the low stop be withdrawn with the engine throttle in retarded position, a sudden increase in propeller windmilling drag results, possibly causing a great danger.
Accordingly, to ensure fail-safe feature the electro-hydraulic stop is provided, whereby the propeller pitch angle is kept above 12° in order to prevent the withdrawal of the low stop from being effectuated by some reason or other, and to prevent the propeller from being fined down to the ground pitch, even when the low stop lever is in "FLIGHT" position.
At the propeller pitch angle of 12° is provided a hub switch, which is designed to be ON when the pitch is fined down below 12°. When the low stop lever is in "FLIGHT," its circuit is completed to excite the pitch coarsen

into the increase line to feather the propeller automatically.
During feathering pump operation, the feather pump light is lighted.
In the case of auto-feather, the auto-coarsening circuit remains completed even after the completion of feathering, and the feathering pump keeps operating. Feathering pump operation is limited within three minutes; and accordingly the auto-feathering circuit must be released to stop the feathering pump. To stop the pump, break any one condition of the aforementioned requirements. Generally, however, auto-feather can be cancelled by successively performing manual feathering operation.

5.4.3 Manual Feather

Manual feather can be performed under any condition. For feathering the propeller manually, set the H.P. cock lever in "FEATHER" position and push down the feather/unfeather switch until feathering is completed.
When H.P. cock lever is placed in "FEATHER" position, the lever pull up mechanically the governor piston valve of P.C.U. to lead the hydraulic pressure into the increase line. The hydraulic pressure is supplied by the feathering pump, which is operated by means of the feather/unfeather switch. The feather/unfeather switch is a push-button switch. While the switch is kept depressed, the feathering pump continues operating and the indicator light built in the switch is lighted. In the case of auto-feather, the pump operates automatically without depressing the switch, but the indicator light is kept on during pump operation.
When feather is manually done, the auto-feather circuit of the engine is opened and that of the other engine also can not be closed.
When the H.P. cock lever is placed in "FEATHER" position, the solenoid isolating valve of P.C.U. also is operated to check the flow of the hydraulic pressure to the two pitch stop withdrawal solenoids; and therefore both high and low stops can not be withdrawn.

5.4.4 Unfeather

To unfeather the propeller in flight, move the H.P.cock lever to "FUEL ON" or "LOCK OUT" and then push the feather/unfeather switch.
When the H.P. cock lever is placed in "FUEL ON" or "LOCK OUT" position, the P.C.U. piston valve is lowered by the governor spring load. In this state, when the feather pump is operated, the hydraulic pressure is fed into the decrease line to unfeather the propeller.
When the propeller is unfeathered in flight, no starter switch is used and no spark flies from ignition plugs. Accordingly the relight switch must be pushed "ON" in advance.
In unfeathering the propeller, change the initial propeller pitch by the above-mentioned method, and the propeller continues windmilling by itself; and accordingly there is no need of keeping the feather/unfeather switch pushed down.
The throttle lever must be kept in the FULL-CLOSE position. If the throttle lever is set above 12,800 rpm, all of the requirements of auto-feather are fully satisfied when the H.P. cock lever is placed in either "FUEL ON" or "LOCK OUT" position; and therefore the auto-coarsen circuit is closed and unfeathering can not be performed.

5.5 Propeller Synchronizer

5.5.1 General

The duty of this propeller synchronizer is to synchronize the speeds of both engines for the purpose of reducing aircraft vibrations, noises, and pilot's discomfort, so that the pilot can be always free from fatigue likely to be caused by engine control. The master engine is the right-hand engine, which, therefore, is not controlled by this synchronizer. The left-hand engine is a slave engine, its speed being synchronized to that of the right-hand engine by means of the synchronizer corrector unit.

5.5.2 Mechanism

In the right- and left-hand engine gear boxes are installed the synchronizer alternators. The left-hand engine is connected to the corrector motor by the engine power control linkage.

Any difference between the right and left alternator speeds sends an electric signal to the corrector motor, and the corrector unit controls the engine fuel flow and the propeller control unit until both alternators are fully synchronized.

Actually, the engine control system is actuated by the throttle link by the corrector motor, while the throttle lever is stationary by means of the frictional brake. As the sudden operation of the throttle may result in an alteration of the "datum" setting of the synchronizer motor, the throttle should be operated cautiously.

5.5.3. Synchronizer Operation

The synchronizer can be operated by turning the synchronizer switch "ON" in the cockpit.

In view of the construction of the synchronizer, the maximum permissible range of speeds is about ± 250 rpm, being effective merely for the constant speed range above 11,000 rpm.

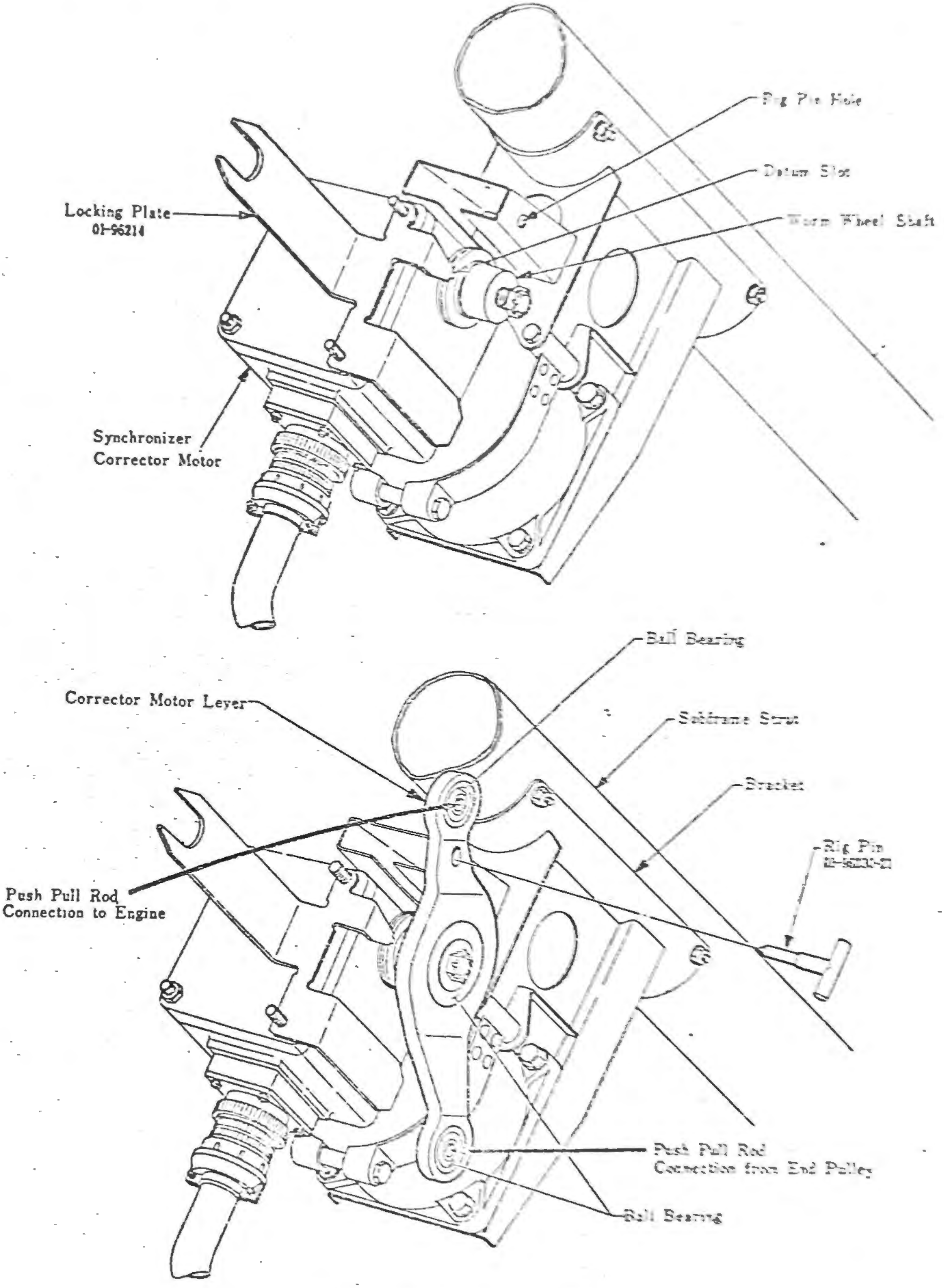
If the speed correction is required or unstable condition exists while the synchronizer is in operation, stop the synchronizer once and, after the readjusting the throttle, restart the synchronizer.

5.6 Propeller Brake

The only left-hand propeller is provided with the brake so that the loading and unloading of passengers can be quickly done after the engine has stopped. The braking system is installed in the gear box and operated with the hydraulic pressure. It is controlled by the propeller brake switch located in the cockpit. (For details, refer to the section of "Hydraulic System.")

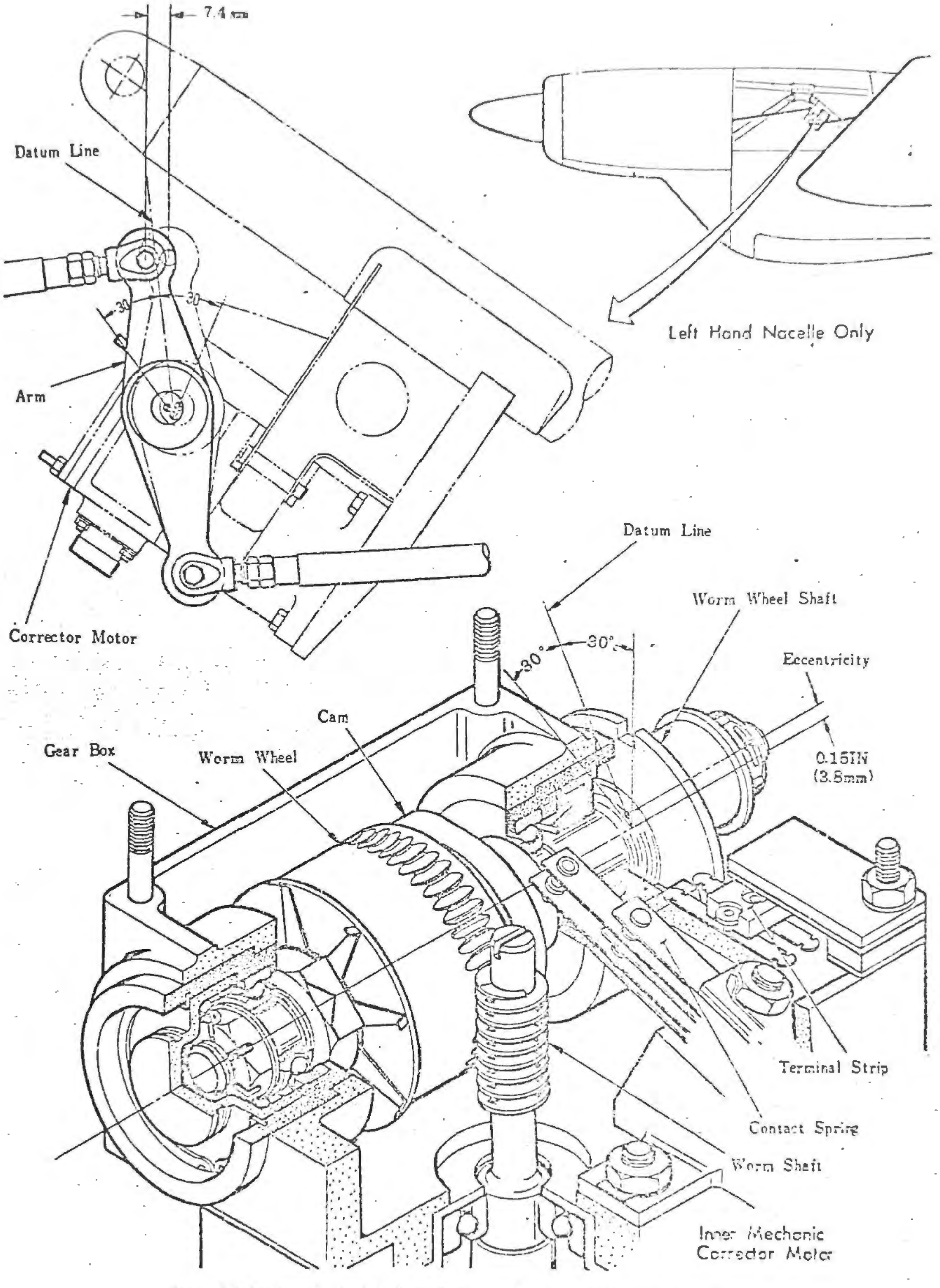
In order to ensure safety, the propeller brake is designed to be applied only when No. 1 H.P. cock lever is in "FUEL OFF" position. Also, when the propeller brake switch is "ON," the engine can not be started.

The propeller brake should be used only when the engine speed is below 3,000 rpm.



Locking-Synchronizer Corrector Motor

Fig. 5-18



Inner Mechanism of Synchronizer Corrector Motor and Operation Diagram

Fig. 5-19

solenoid in order to pull up the piston valve in the propeller control unit, passing the oil into the increase line to increase the pitch angle above 12°. When the low stop lever is placed in "GROUND," this circuit stops operating. Accordingly the low stop lever should never be moved into "GROUND" position for any reason during flight.

5.3.3.3 Low Stop Unsafe Light

When the low stop withdrawal solenoid is excited, this unsafe light comes on. Accordingly this is always lighted as long as the low stop lever is in "GROUND" position. In "FLIGHT" position, if the light is lighted or does not go out, it means there is a trouble in the low stop system. In such a case, it is necessary to pay a full attention to it.

5.3.3.4 Below Low Stop Light

The stop light is provided one to each propeller. It comes on when the hub switch at the pitch angle of 12° of the propeller is ON. Provided this lamp is lighted (actually, flickers) even when the low stop unsafe light is off, it indicates that the low stop has been withdrawn and the electro-hydraulic stop is in operation.

5.4 Feather and Unfeather

5.4.1 General

Feathering the propeller is carried out by increasing the propeller pitch angle to the maximum 84.5° by applying the hydraulic pressure to the increase side of the propeller cylinder.
In this case, the hydraulic pressure is supplied by the feathering pump and sent into the increase line with the propeller piston valve in P.C.U. pulled up. Feather may be divided into Auto-Feather (Auto-Coarsening) and Manual Feather by the method of pulling up the piston valve.

5.4.2 Auto-Feather

In the event of an engine trouble during flight, the propeller is automatically feathered by the automatic coarsening device, which is designed when all the following requirements are satisfied.

(1) The throttle lever is in a position above 12,800 rpm.

(2) The H.P. cock lever is in "FUEL ON" or "LOCK OUT" position.

(3) The other engine is not in the auto-feather or manual-feather position.

(4) The engine torque pressure is below 50 psi.

When these requirements have been fulfilled, the auto-coarsening electrical circuit is completed to excite the auto-coarsen relay, turning the feathering pump. At the same time, the pitch coarsen solenoid is excited to pull up the piston valve in P.C.U., actuating the feathering pump to pass the oil

5.7 Propeller Operation

5.7.1 Ground Operation

Before the engine run-up on the ground, make sure that the low stop lever is in "GROUND" position and the gust lock lever is in "LOCK" position. The H.P. cock lever in this case must be in "LOCK OUT" position. This is for the purpose that the propeller blades can be moved back to the ground fine pitch if the engine power is reduced.

5.7.2 Engine Start

Prior to starting the engines, make sure that the propeller blades are at the ground fine pitch of 0°. This is very important for the prevention of hot start. For easy determination of the propeller blade position, red marks are provided at the roots of propeller spinner and blade.
If the pitch is still above 0°, decrease it to the ground fine pitch by the following procedures:

(1) Power supply - ON.
(2) Engine H.P. cock concerned - LOCK OUT.
(3) Feathering Sw - To be kept pushed down till the pitch becomes 0°.

The propeller pitch remains at 0° even if the ground idling speed increases after engine start. Further, at the beginning of throttle lever movement from CLOSE to OPEN, the P.C.U. piston valve remains in the lowered position because of the presence of the dead movement of the governor spring rack sleeve. The propellers, therefore, are kept at the zero pitch angle, and only the engine speed and fuel flow continue to increase until the minimum constant speed is reached. At this point where the minimum constant speed has been reached, the piston valve in actuated to maintain the engine speed at 11,000 rpm. Even if the throttle lever is further moved towards OPEN position, the fuel flow continues to increase and the pitch angle becomes greater so far as there still exists the residual dead movement; and the engine speed is kept at 11,000 rpm.
Move the throttle lever further toward OPEN, and the governor spring is compressed and the engine speed increases until it is balanced with the spring load.
On the ground, if the throttle is opened to take-off power, the propeller exceeds the low stop. When the low stop lever is in "GROUND" position, the low stop unsafe light remains ON but the below low stop light is OFF.

5.7.3 Take-off

When the gust lock lever is placed in OFF position, the throttle lever and low stop lever are unlocked.
During take-off, the propellers will not go over the high stop, except when the throttle lever is operated abruptly. In order to prevent the propellers from being caught by the high stop - resulting in high T.G.T., the H.P. cock lever should be placed in "LOCK OUT" position.
Move the throttle lever through its travel to FULL OPEN, the low stop lever also advances to FLIGHT position, the low stop being formed. And naturally the low stop unsafe lamp and the below low stop lamp go out.

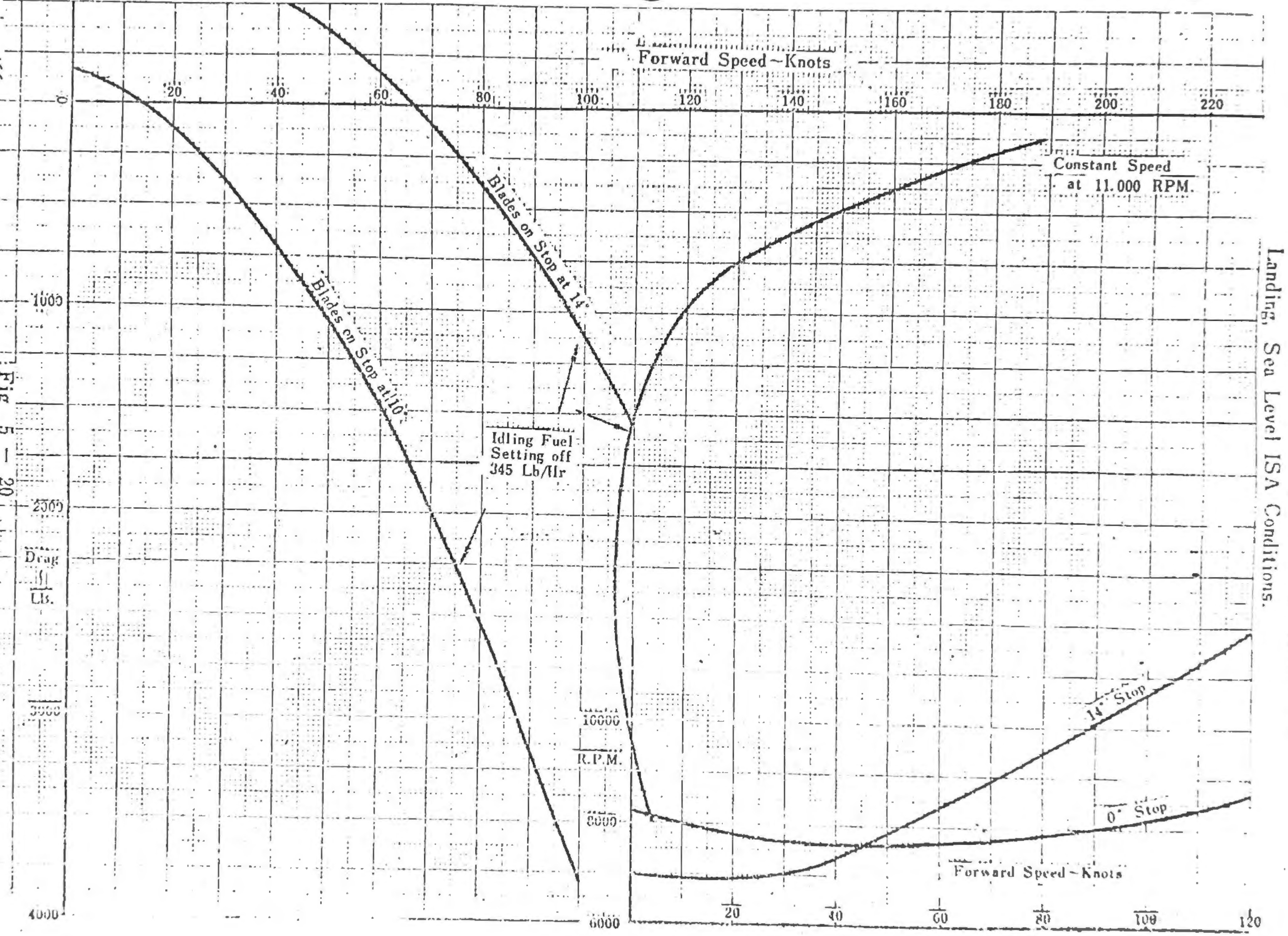


Fig 5 — 20

Drag & Engine RPM Values During Approach & Landing, Sea Level ISA Conditions.

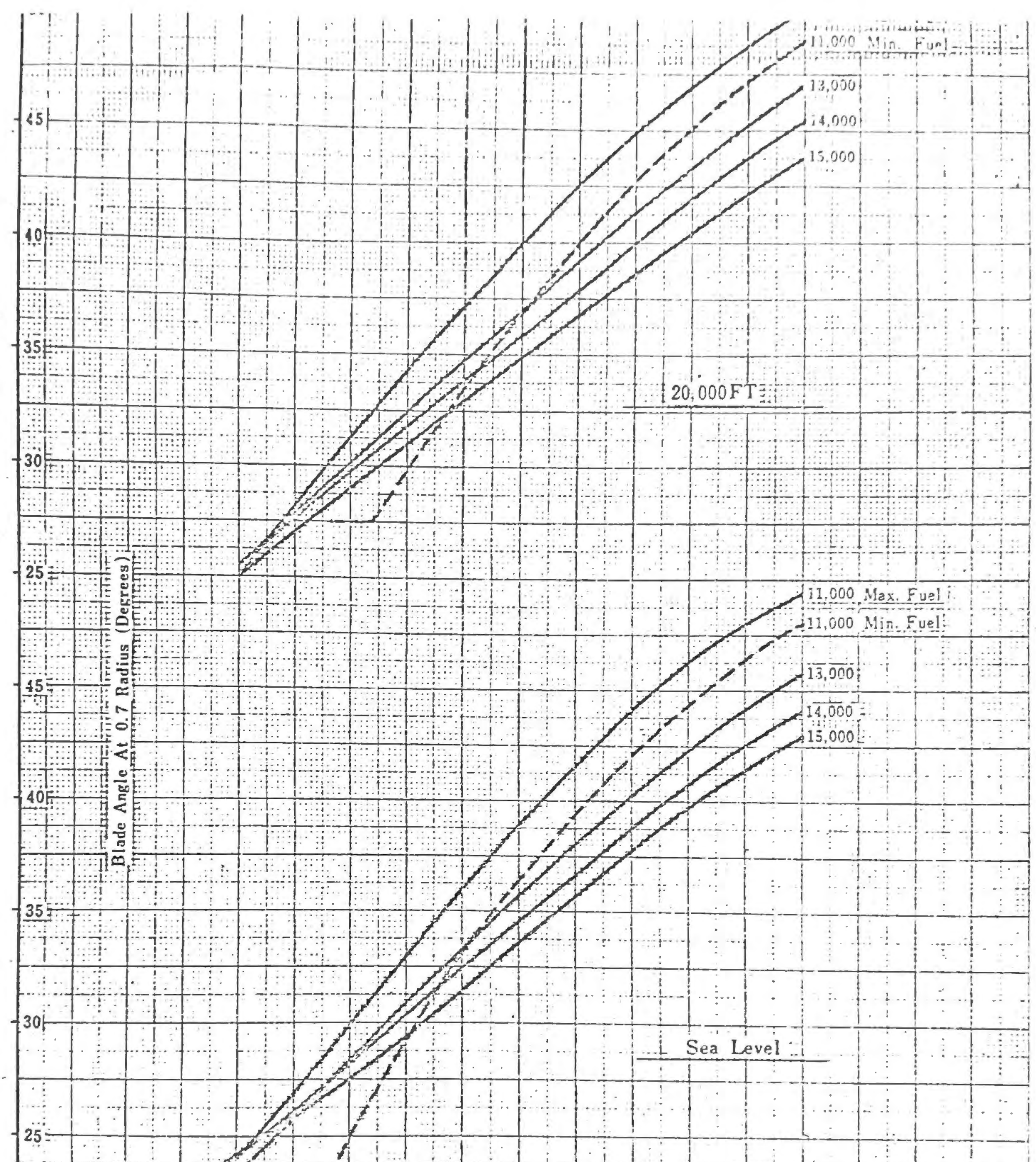

11,000 Min. Fuel
13,000
14,000
15,000
20,000FT
45
40
35
30
25
Blade Angle At 0.7 Radius (Degrees)
11,000 Max. Fuel
11,000 Min. Fuel
13,000
14,000
15,000
Sea Level
45
40
35
30
25
20
15
0
100
200
300
400
Forward Speed—Knots (TAS)

Fig 5 — 21

Once formed, the low stop will never be withdrawn so long as the low stop lever will not be moved to "GROUND." Should take-off be aborted, the low stop lever must be returned to "GROUND" position.

5.7.4 Cruising

After take-off, the H.P. cock lever should be shifted to "FUEL ON" so that the high stop can be formed at any time.
As engine speed increases, the propeller pitch also increases, passing the hub switch at 29.5° at T.A.S. 187 kts in an ordinary cruise and forming the high stop. In this case, both the high stop remove light and high stop unsafe light go out. Provided one propeller is in contact with the hub switch at 29.5°, the high stop is formed; and the high stop remove light is out while the high stop unsafe light remains on.
If the high stop is not formed or the high stop unsafe light remains on even above T.A.S. 187 kts, set the propeller emergency switch to "EMERGENCY" to form the high stop.
If this operation is not enough to form the high stop, the air speed should not exceed T.A.S. 227 kts.
This is because, in case of an engine trouble, the propeller will not stop at the high stop but be caught by the low stop, making windmilling operation.
In the event of a trouble with the P.C.U. constant speed governor function, the number of revolution of the propellers becomes about 25,200 rpm at the time of windmilling which is the limit of propeller overspeeds. Operation up to this speed, is considered safe. At T.A.S. 145 kts, the speed is 16,500 rpm.
On the other hand, since the force exerted on the vertical tail by the unbalance of power between both engines due to the drag of windmilling propeller is limited to C.A.S. 187 kts at the altitude of 13,000 ft or lower, the air speed should not exceed this speed in case that the high stop is faulty.
Nor should the H.P. cock lever be placed in "LOCK OUT" when the air speed exceeds this limit.
As long as the high stop is formed, the propeller pitch does not go down below 27.6° if it goes down due to some reason or other.
If both propellers decrease in pitch angle, down to 29.5°, the hub switch works and the high stop unsafe light comes on, the high stop being withdrawn and the high stop remove light coming on. Note that, when the hydraulic pressure on the fine pitch side is not high enough to withdraw the high stop, the speed in some cases drops slightly below the selected speed till the high stop is withdrawn.

5.7.5 Approach and Landing

At the time of approach, the propellers are spinning at more than the minimum constant speed. Move the throttle lever fully to CLOSE for low speeds, and the propellers are caught by the low stop at 14°, the speed dropping to less than 11,000 rpm. However, neither the low stop unsafe light nor the below low stop light will come on until the low stop lever is placed in "GROUND" after the airplane has touched the ground.
After landing, withdraw the low stop, and the propellers decrease in pitch from 14° to the ground fine pitch stop, receiving a great drag.

If the low stop is not formed during approach or during landing for some reason or other, the propeller pitch decreases below 14° and the hub switch at 12° will be ON to form the auto-coarsen circuit, so that the propellers are prevented from decreasing in pitch below 12°. At this time, the low stop unsafe light does not come on but the below low stop light flickers on and off. In such a case, open the throttle to some extent to maintain the propeller pitch above 12°.

Propeller Pitch Stop Light Indications

Condition	Throttle Position	Low Stop Lever	TAS Kt. Approx.	Indicator Light			
				1	2	2	1
				Low Stop Unsafe	Below Low Stop	High Stop Remove	High Stop Unsafe
Before Engine Start	Idle	Ground	0	ON	ON	OUT	ON
Ground Idling & Taxiing	Idle to Taxi RPM	Ground	0	ON	ON (OUT)	ON	ON
Take-Off	Max Power	Flight	0～120	OUT	OUT	ON	ON
Power Reduction to Climbing	As Required	Flight	130	OUT	OUT	ON	ON
Cruise	As Required	Flight	≧ 187	OUT	OUT	OUT	OUT
Approach	As Required	Flight	≦ 187	OUT	OUT	ON	ON
After Touch Down	Idle	Ground	80 ～ 0	ON	ON	ON	ON

Chapter 5 FUEL AND WATER/METHANOL SYSTEM

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Chapter 5 FUEL AND WATER/METHANOL SYSTEM

5.1 General Description

5.1.1 Fuel System

(1) Fuel Tank

Fuel tanks are located inside starboard and port wings. Main fuel tanks are integral and installed outboard the engine nacelle. There is a provision for bag tank installation as auxiliary tanks to meet customer's requirement. Auxiliary tanks are installed between the front and the rear spars of starboard and port wings inboard the engine nacelle.

(2) Fuel Refueling

Fuel refueling is implemented by pressure feed system through the filler located on the lower surface of the wing. Alternatively, gravity refueling is accomplished through the over wing filler.

(3) Fuel Specifications

Fuel used in this aircraft shall conform to the following specifications.

Group A

ASTM D 1655-59T Type A or Type A-1
British D. Eng. R.D. 2482, 2494 or 2498
Canadian 3-GP-23e Type 1
I.A.T.A. Kerosine Type Fuel
MIL-J-5624F Grade JP-5

Group B

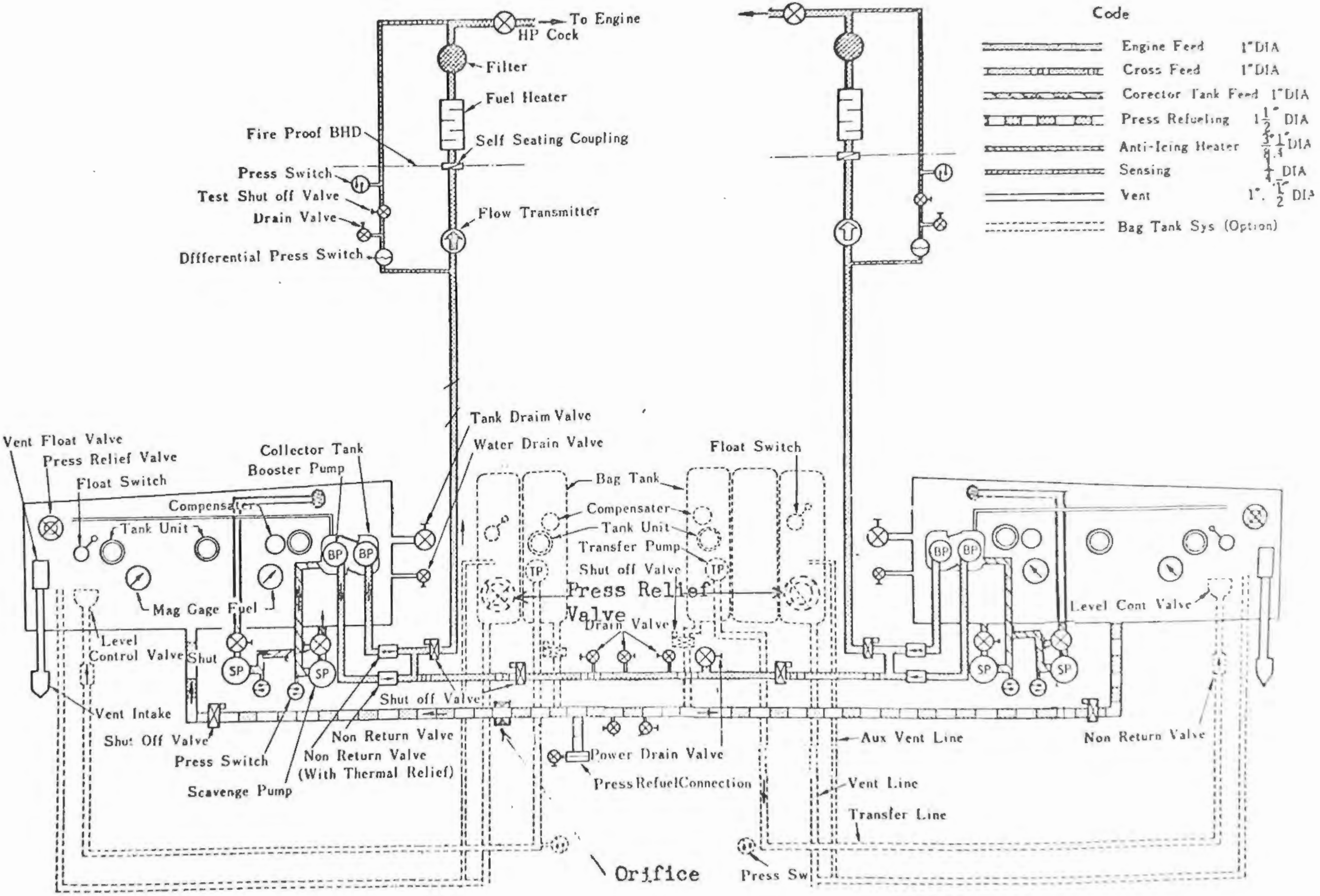
British D. Eng. R.D. 2486
Canadian 3-GP-22d Type 2
ASTM D 1655-59T Type B
I.A.T.A. Wide-cut Type Fuel
MIL-J-5624F Grade JP-4

(4) Fuel Feed

Fuel is supplied to engines from main tanks under pressure by means of the submerged type booster pump. The pressure supply is intended to prevent vapor lock in the system.

Fuel in auxiliary bag tanks is transferred to main tanks by means of the fuel transfer pump.

Cross feed system is incorporated between starboard and port main tanks. The collector tank which forms an isolate chamber, and a scavenge system are installed in the main tanks to minimize the unusable fuel quantity in the tanks.



Fuel System Piping Schematic Diagram
Figure 5-1

(5) Fuel De-icing

The fuel de-icing system is installed in the fuel feed line to prevent fuel from icing.

(6) Fuel Quantity Indicating System

The fuel quantity indicating system is provided with two kinds of fuel gauges; two direct reading fuel quantity indicator mounted on the lower surface of the wing and an electrical capacity type fuel quantity indicator mounted on the pilot instrument panel.

(7) Cap Identification Marking

The following colors are painted on the filler caps for identification purpose:

W/M Filler Cap	White
Fuel Filler Cap	Red
Oil Filler Cap	Yellow

(8) Valves and pipes which can not be identified easily are provided with placards and marking tapes, respectively.

5.2 Fuel Tank - Integral

5.2.1 General Description of Integral Fuel Tank

The integral fuel tank is provided, one in each of the right- and left-hand wings, located between W. STA 4000 and W. STA 9600, being formed by bulkheads and front and rear spars with a vent. On the lower surface of the wing are installed four manholes for inspection of tank interior and one booster pump attaching mount.

The manhole cover is sealed with rubber gasket and secured with screws. On the upper surface of the wing is located one filler cap for alternative fuel refueling means (gravitation refueling); no other inspection holes are provided.

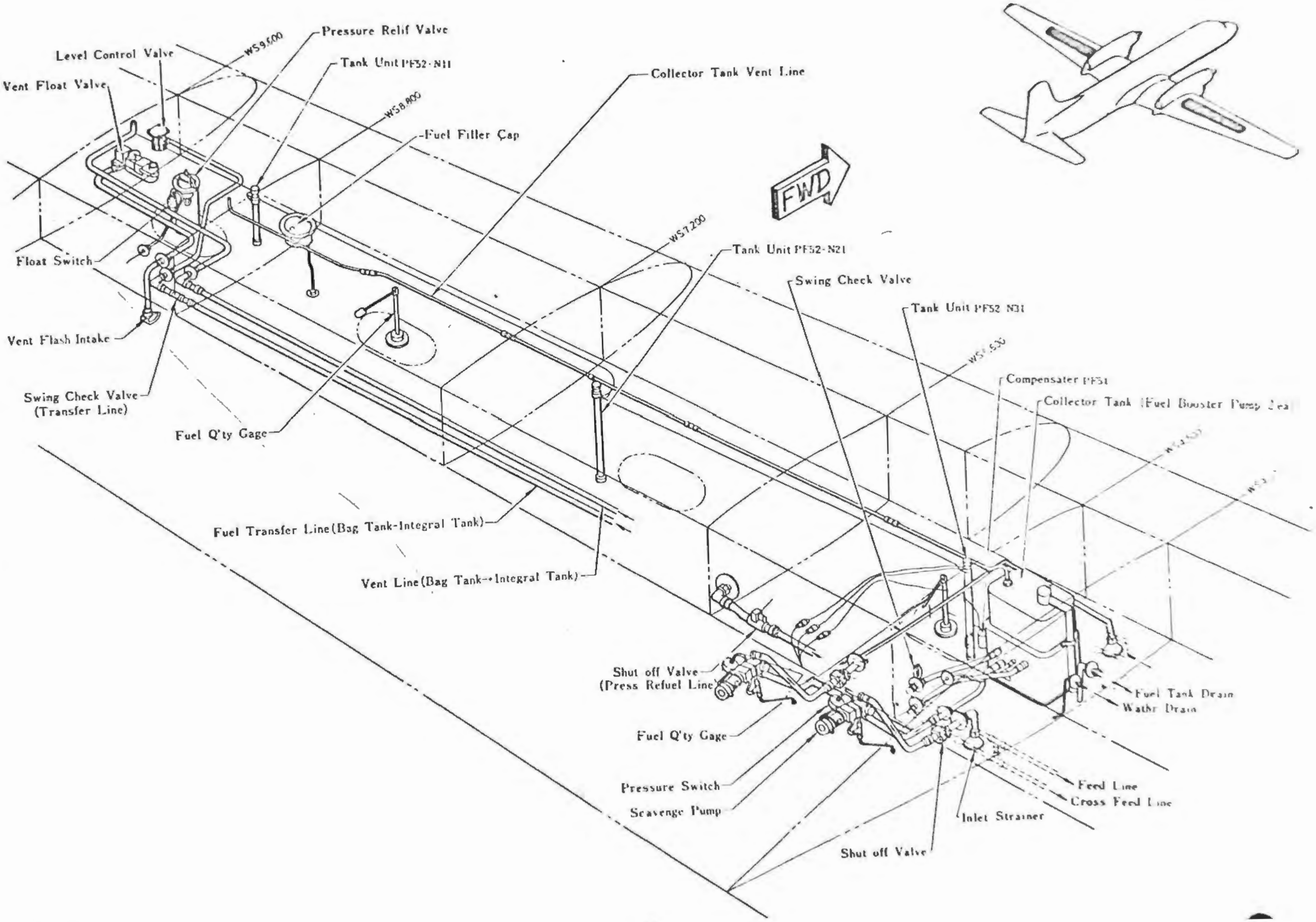
Inside the tank the components of each sub-system are installed. Of the components, most of those which are connected to pipes and electric wires outside the tank have their connections on the face of the rear spar.

Components installed inside the tank are, except the booster pump, checked or replaced through the manholes. Before accomplishing checks and replacement of components, the fuel shall be defueled entirely.

The fuel tanks are numbered as follows:

L.H.	Integral	Tank	No. 1	(Main Tank)
L.H.	Bag	Tank	No. 2	(Aux Tank-Option)
R.H.	Bag	Tank	No. 3	(Aux Tank-Option)
R.H.	Integral	Tank	No. 4	(Main Tank)

In case the optional tank is not provided, its number is skipped.



All Equipments in Integral Tank

Figure 5-2

5.2.2 Tank Specifications

Total Capacity	2,644ℓ (about 700 U.S. gallons)
Pressure Refueling Amount	2,495ℓ (about 659 U.S. gallons)
Gravity Refueling Amount	2,520ℓ (about 666 U.S. gallons)
Unusable Fuel Amount	14ℓ (about 3 U.S. gallons)
Expansion Space	124ℓ (equivalent to 4.7% of the total capacity)
Proof pressure of tank	3.5 psi.

Reserved

5.2.3 Construction of Integral Tank (Fig. 5-3)

The inner walls of the integral fuel tank are made up of upper and lower wing panels, front and rear spars, and bulkheads at the wing stations 4000 and 9600. Their inner surfaces are sealed with sealing compound and further top-coated all over.

Inside the tank are installed bulkheads to prevent fuel from centering toward the wing tip when the aircraft is banked to the left or right, and trusses for stiffening the wing structure.

The bulkheads are located at W STA 4500, 5600, 7200 and 8800. Bulkheads except one at W STA 4500 are riveted.

The bulkhead at W STA 4500 is attached with screws and provided with three swing check valves. Between the bulkhead and the stringer a clearance is provided to allow fuel to flow.

Trusses are located at W STA 5100, 6100, 6700, 7700 and 8300. Truss members are detachable to facilitate inspection of the interior.

5.2.4 Tank Sealing - Integral (See Fig. 5-3)

The tank is sealed by the combined use of the following methods and sealants.

(1) Face Sealing (Faying Surface Sealing)

It is a method used on the faying surfaces between the structural components such as the skins, spars, rib and the like, and on the faying surfaces of the reinforcements and longerons mounted directly on the structural components.

Compound to be used: PR-1431 Types I, II and III

(2) Corner Sealing

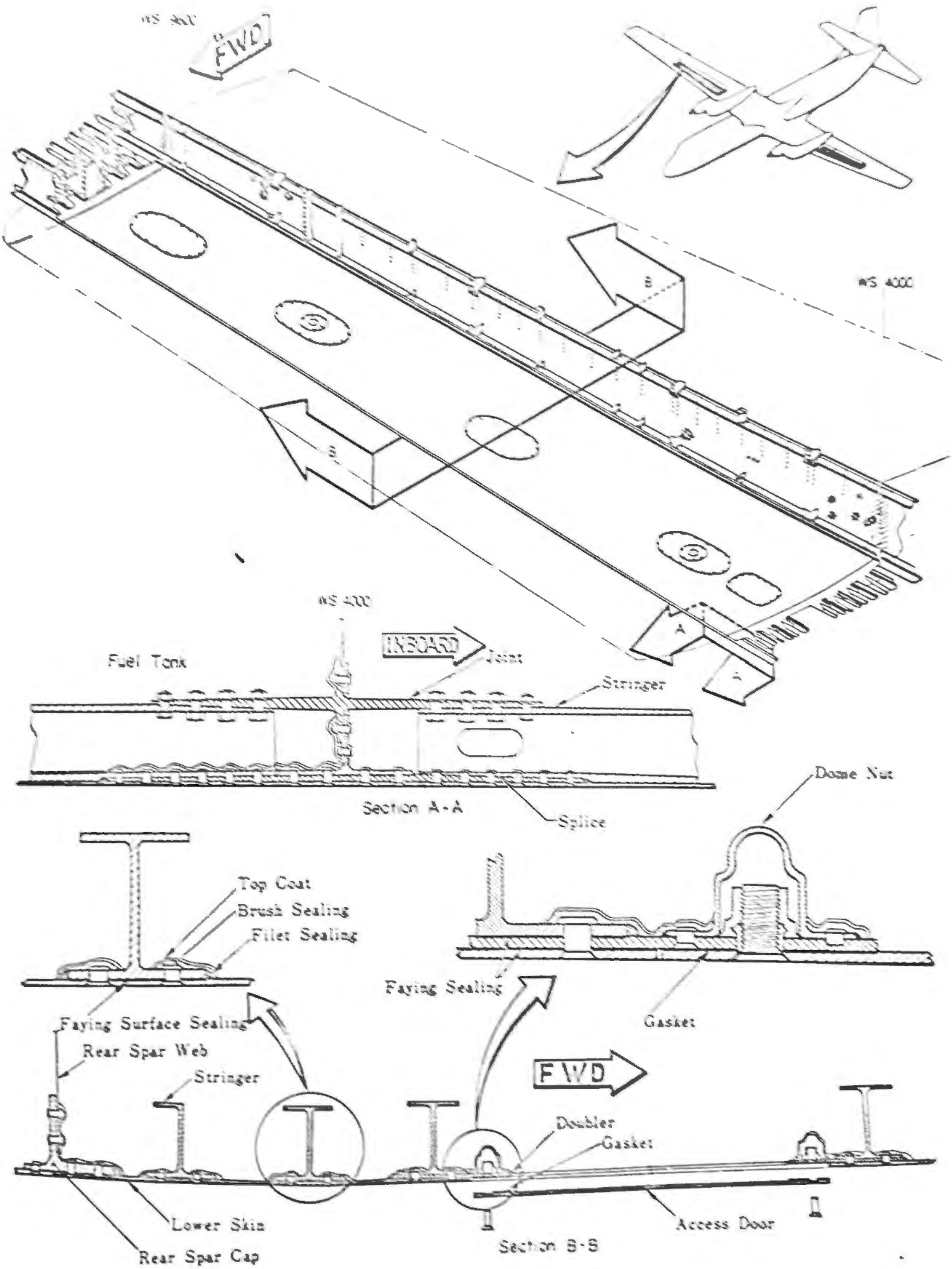
It is a method used for the corners where the structural components are joined together with corner fittings, and is also used for the corners, grooves and where there are gaps.

Compound to be used: PR-1422 Class B-2

(3) Fillet Sealing

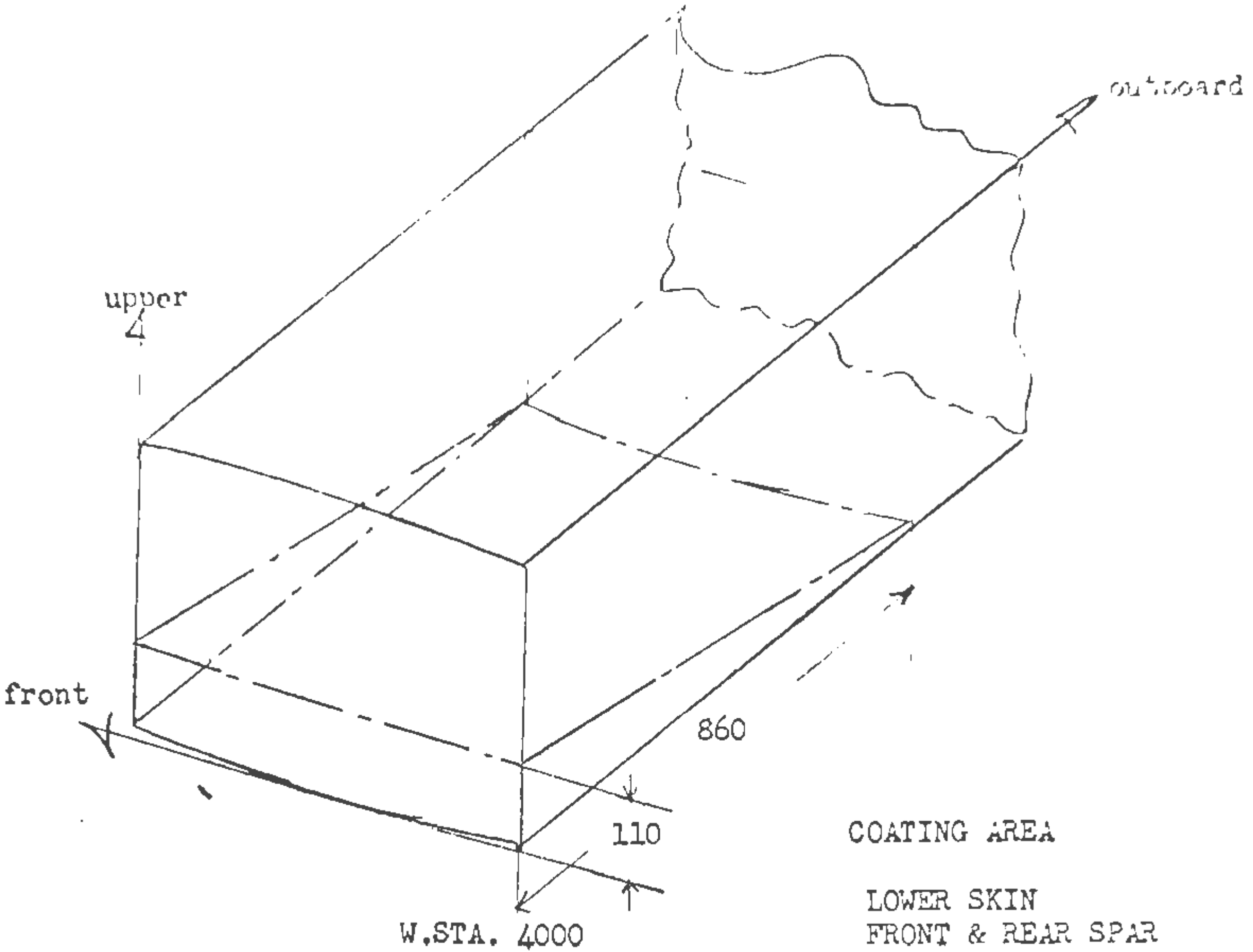
Fillet sealing is employed where the skins, reinforcements and longerons are joined together and for the joints and gaps which are likely to cause leakage all around such points.

Compound to be used: PR-1422 Class B-2



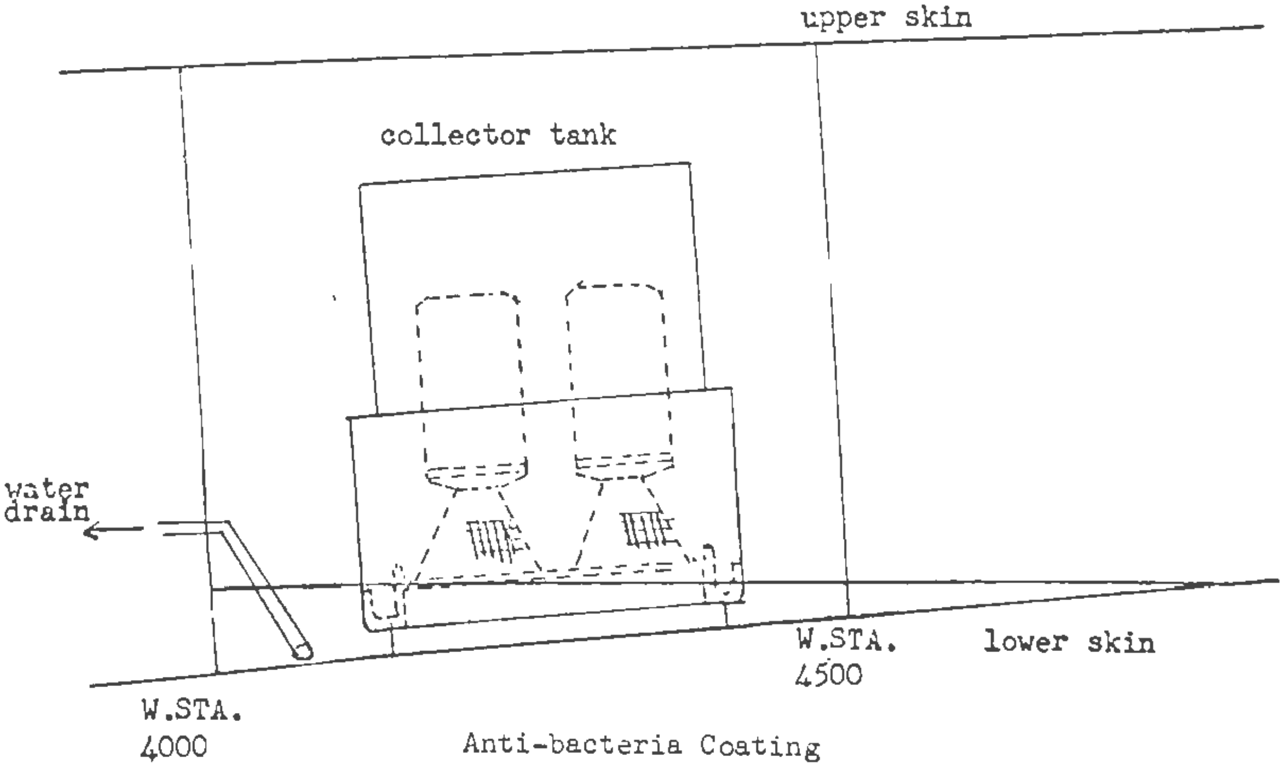
Integral Tank Structure General

Figure 5–3



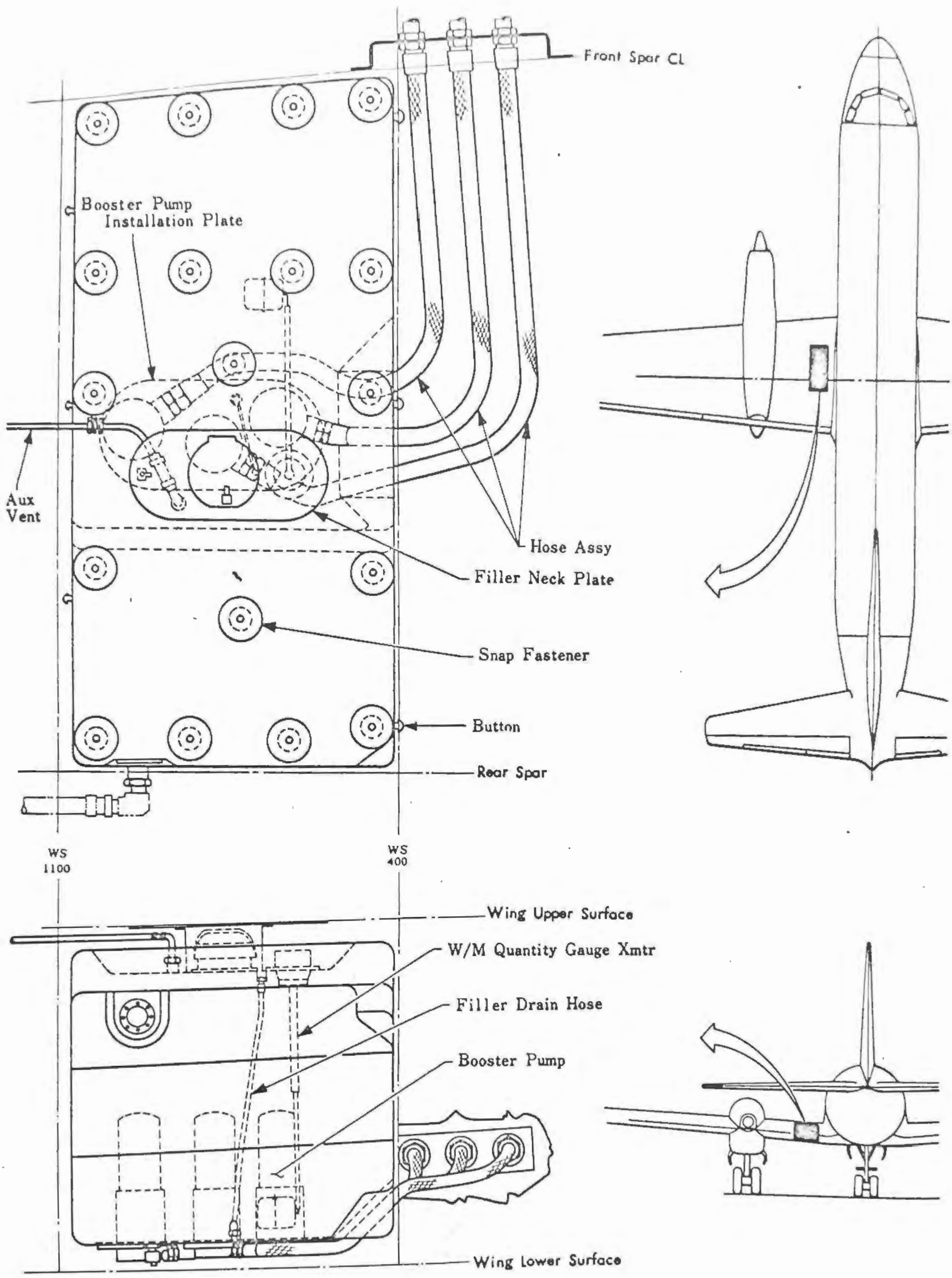
COATING AREA

LOWER SKIN
FRONT & REAR SPAR
W.STA.4000(only outside)
& W.STA. 4500 BULKHEADS
COLLECTOR TANK



Anti-bacteria Coating

Figure 5-3A



W/M Tank Installation (Locking from Upper and Aft)
Figure 5–38

Replenishment of water/methanol is accomplished through the filling port on the upper surface of the wing. (Maximum Capacity 111 U.S. Gal.)

5.9.3 Specifications of Water/Methanol

Specifications for the water/methanol conform to Rolls-Royce Specification for AEP-1-W/M, ISSUE 5, AMENDMENT 2.

British Standard 506 : 1958
American Federal Specification O-M-232d (Grade 4)

As for the mixing ratio, methanol and water are mixed in weight ratio as follows:

Methanol	CH_3OH	37 ± 1%
Water	H_2O	63 ± 1%

5.7.4 Water/Methanol Sub-system

(1) Water/Methanol Feed System (See Figs. 5-39, 5-40 and 5-41)

Three submerged type booster pumps are installed at the bottom of the tank for delivery of water/methanol to both right and left engines under pressure.
Water/methanol boosted by and delivered from the booster pump passes through the non-return valve and comes into the collector pipe located in front of the wing front spar, from which water/methanol flows to either engine through the feed line. A shut-off valve, filter and pressure switch are installed in this feed line. The feed line is a 1 inch diameter stainless steel pipe.

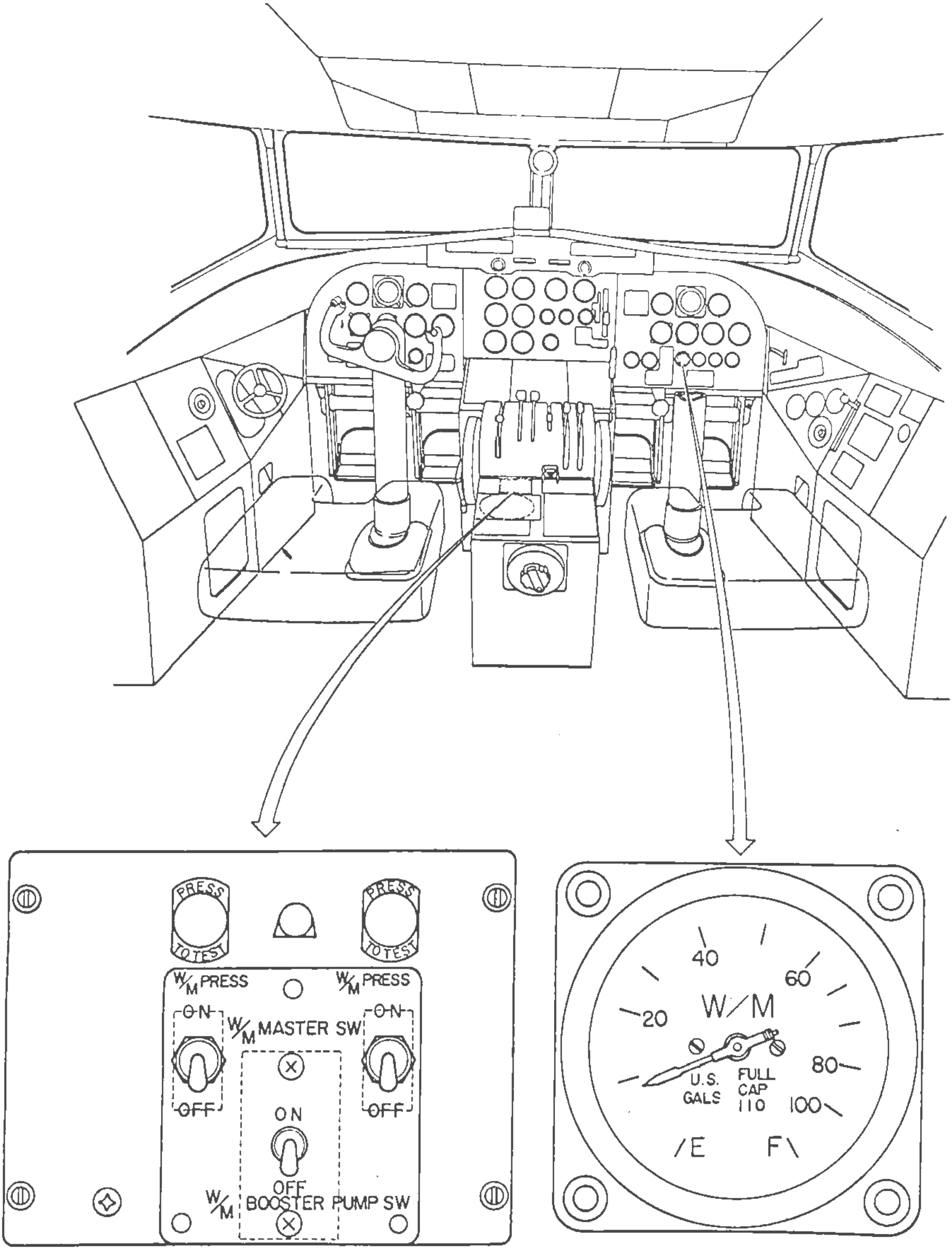
Operation of Feed System

At the center pedestal in the cockpit, the water/methanol control panel is located. Turn the water/methanol booster pump switch "ON," then the three booster pumps start to operate simultaneously. Advance the H.P. cock lever to the fuel "ON" position or further and turn the master switch "ON," then the shut-off valve is opened, allowing water/methanol to flow to the engine metering unit.

When line pressure exceeds 14 ± 0.4 psi, the pressure switch closes its contact point and the indicating light (green) on the control panel comes on.

Water/methanol which reached the engine metering unit is not injected into the engine until engine speed has exceeded 14,800 r.p.m. as the unit is connected to and controlled by the engine throttle lever by means of the linkage.

An auxiliary vent line is connected to the main vent line on the way, and the vent outlet is opened in the vicinity of W. STA 9,300 near the fuel vent outlet.



W/M Control Panel and Indicator

Figure 5–39

5.9.5 Engine Bleed Air Purge System (See Figs. 5-41 and 5-42)

Engine bleed air is bled from the second stage compressor outlet. The bleed air is utilized as sub-power source of the pressure control unit of the air conditioning system. If water/methanol is injected into the first stage compressor, the air containing water/methanol is fed to those units which may be corroded by water/methanol.

Therefore, when injecting water/methanol, it is necessary to prevent the bleed air from entering into the units and discharge the water/methanol left in the piping outboard so that the non-contaminated air may be fed to the air conditioning system. For this purpose, the purge valve is installed in the engine bleed air line. This purge valve is electrically connected to the feed line shut-off valve.

When the master switch is turned to "ON"

1. Shut-off Valve ⟶ Open

   then,

2. Purge Valve ⟶ Close

Thus the airframe can be protected from water/methanol containing vapor whenever water/methanol is injected into the engine.

When the master switch turned "OFF"

1. Shut-off Valve ⟶ Closed

   then,

2. Purge Valve ⟶ Open

When the purge valve is in the way to open position, the valve is opened to the intermediate purge position. Therefore the water-methanol containing vapor left in the line between compressor outlet and the purge valve is discharged outboard and the clean air is supplied to the air conditioning system control equipment.

5.9.6 Construction of Sub-system

(1) Booster Pump (See Figs. 5-43 and 5-44)

The water/methanol booster pump and the 28V D.C. driven motor of anti-explosion construction are assembled into an integral unit. A radio noise filter and a pump drain hole are provided at the bottom of the pump proper. On the side of the pump are provided an water/methanol outlet, electric contactor and gland drain fitting.

(2) Non-Return Valve (See Fig. 5-45)

The non-return valve is of the same construction as that used in the fuel system.

(3) Shut-off Valve (See Fig. 5-46)

The shut-off valve is a gate valve driven by a 28 volt D.C. motor. The motor and the valve are joined by bolts into one unit. Valve operating time is 2 to 3 seconds.

An indicator is provided to ascertain the operating position of the valve from the outside. The valve has a built-in relief valve (OPEN at 1 psi) to relieve the line pressure.

(4) Coupling (See Fig. 5-47)

The couplings used for piping in general are wiggings flexible couplings and F.R.S. connectors.
These couplings used inside the nacelle are covered with stainless steel shrouds. At the fire wall, quick disconnect couplings are employed to accomplish effective engine change work.

(5) Filter (See Fig. 5-48)

The filter is designed to trap up to 20 micron foreign objects. It has no by-pass valve inside. At the bottom of the filter, the drain valve is installed.

5.9.7 Indicator (See Figs. 5-49 and 5-50)

The water/methanol indicating system consists of the following two.

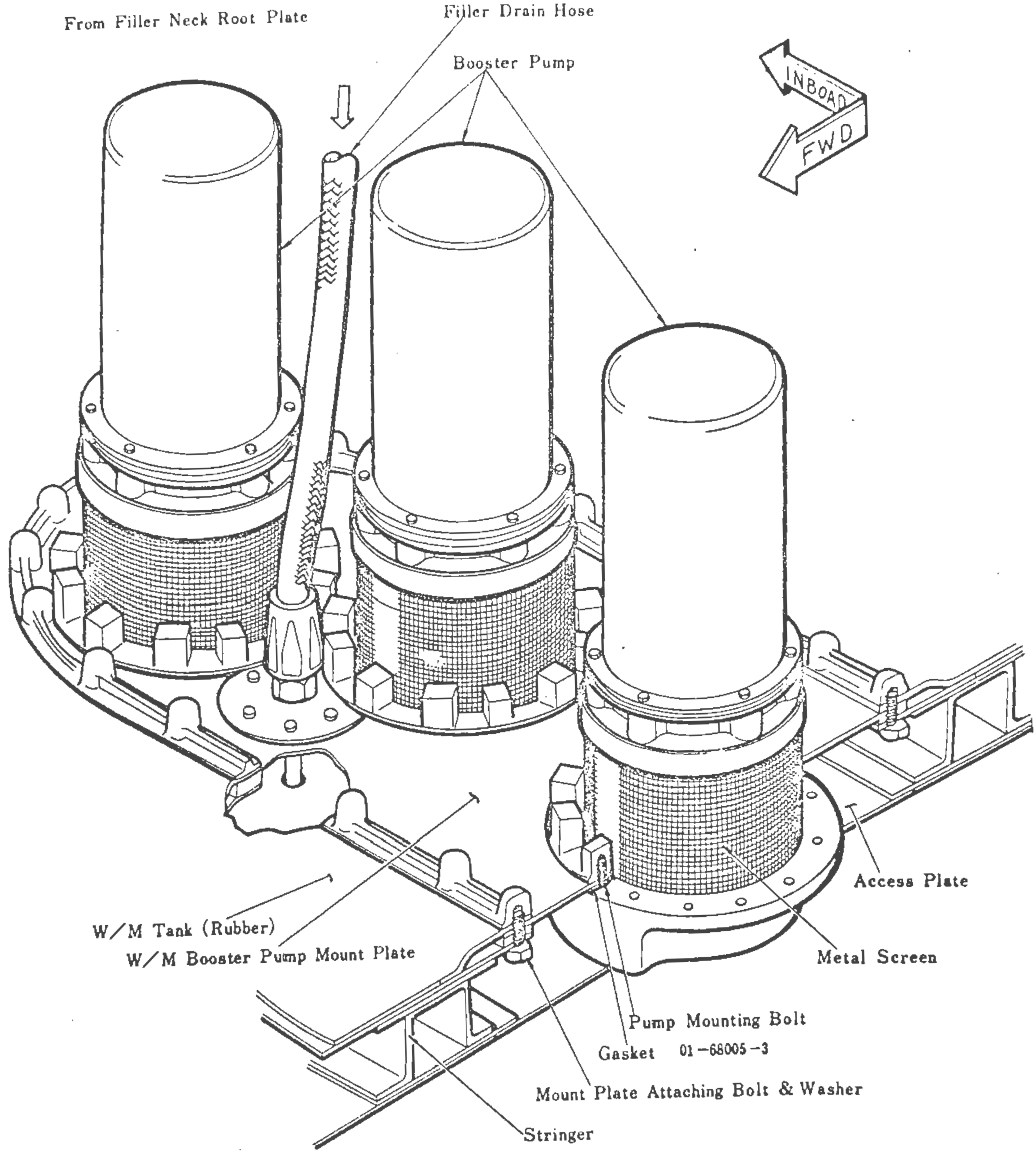
(1) Water/Methanol Quantity Indicator

The motion of the transmitter, suspended from the ceiling in the tank, corresponding to the height of the liquid level is converted into a change in electric resistance to indicate the quantity.

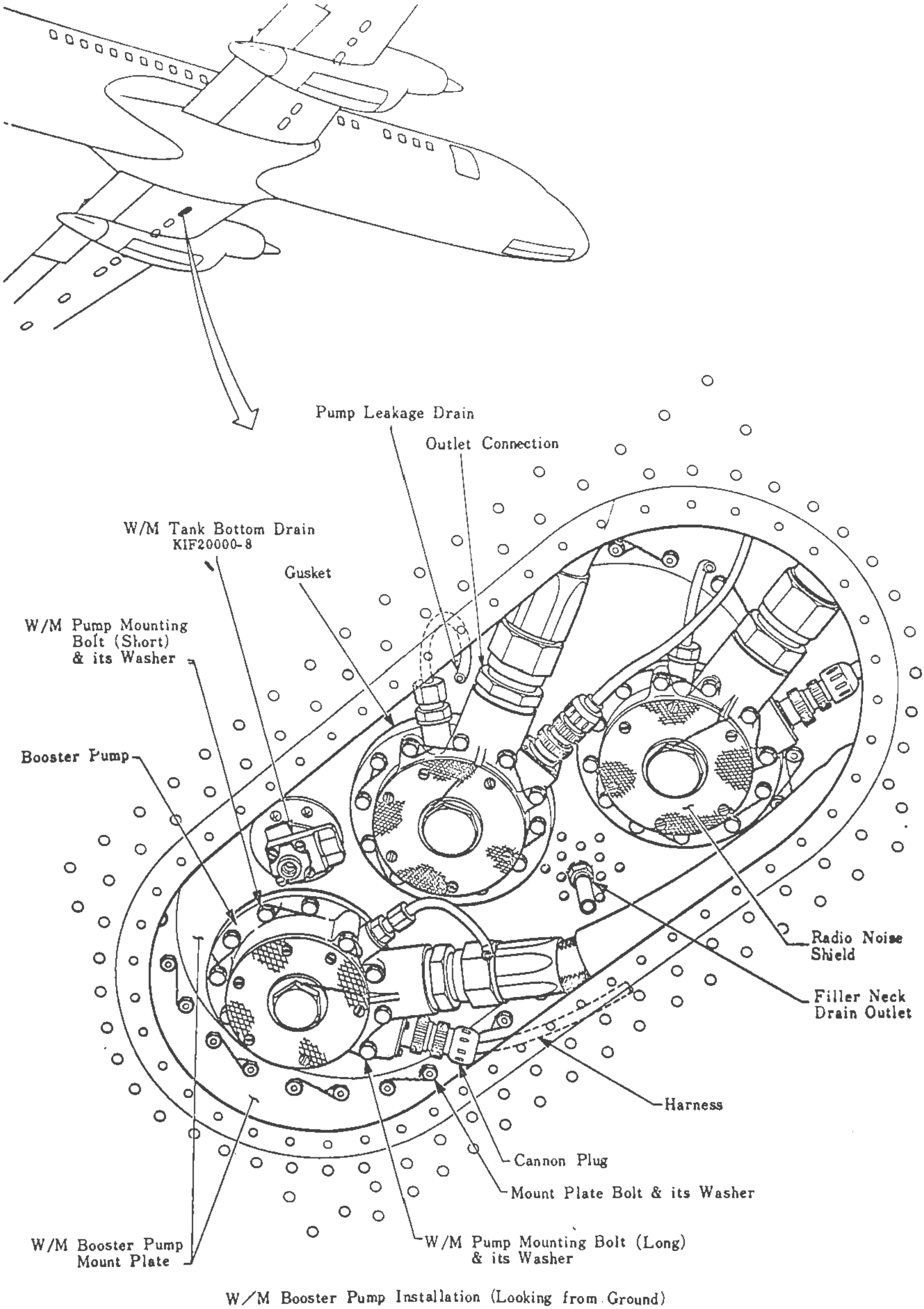
Indication is given in U.S. gallons. The scale is graduated from Empty (0 U.S. Gal.) to Full (111 U.S. gal.) at unequal angles within the indicating range of 300 degrees.

(2) Water/Methanol Pressure Indicator

The indicating system indicates the pressure of the water/methanol being supplied to the engine at the time of water/methanol injection. When the pressure of water/methanol exceeds the prescribed value, 14 ± 0.4 psi, the indicating light (green) comes on.

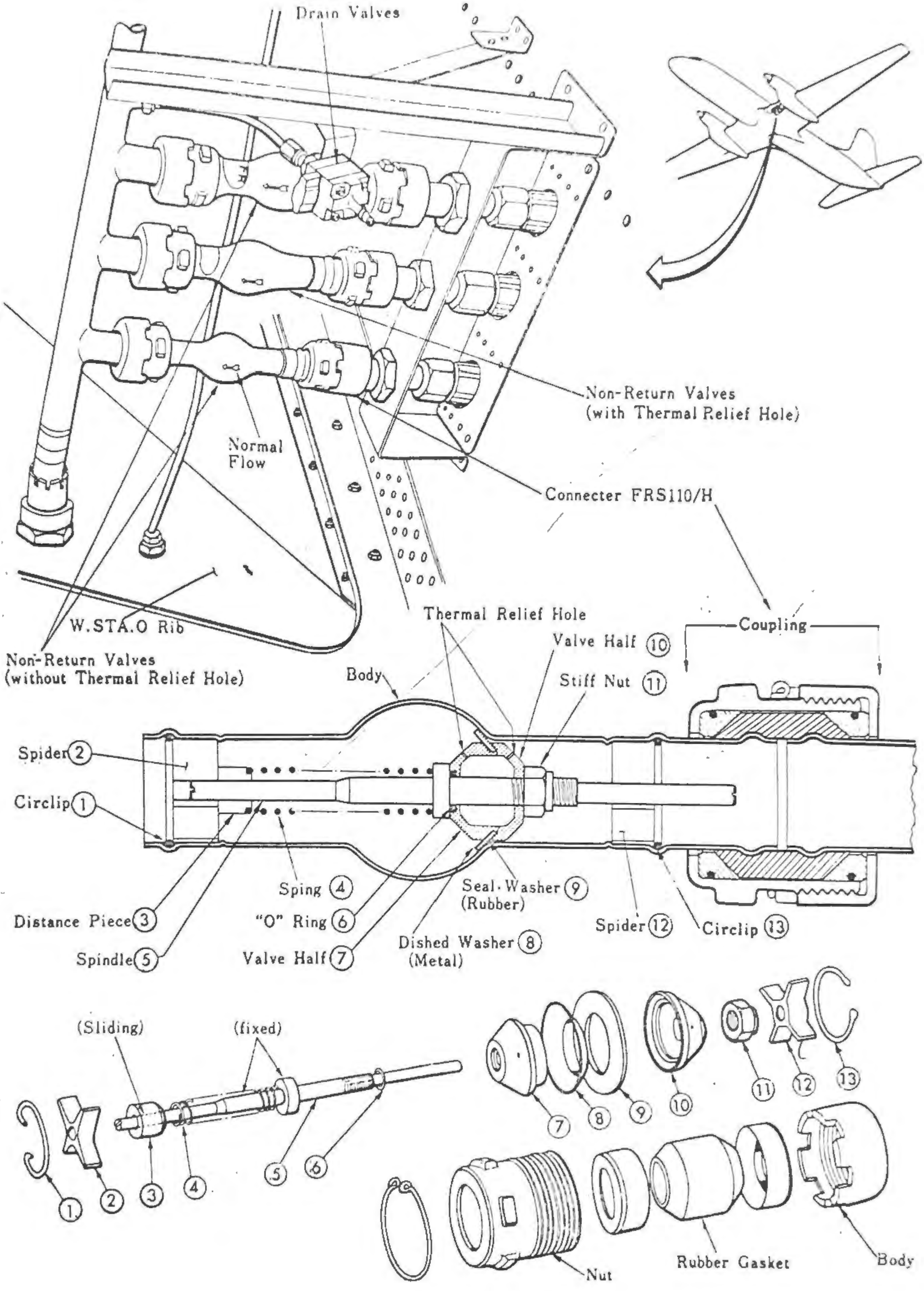


W/M Booster Pump Installation
Figure 5–43



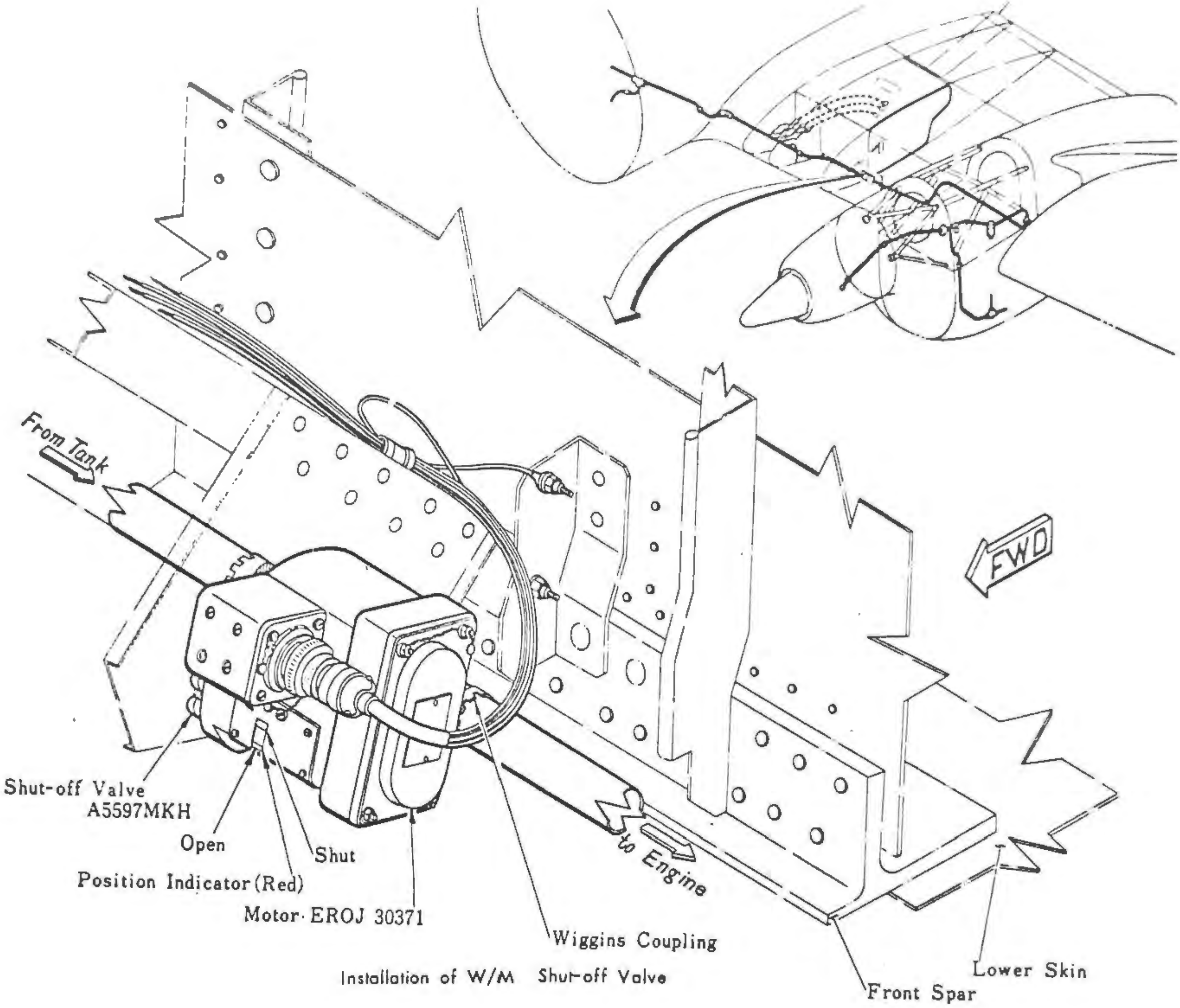
W/M Booster Pump Installation (Looking from Ground)

Figure 5–44

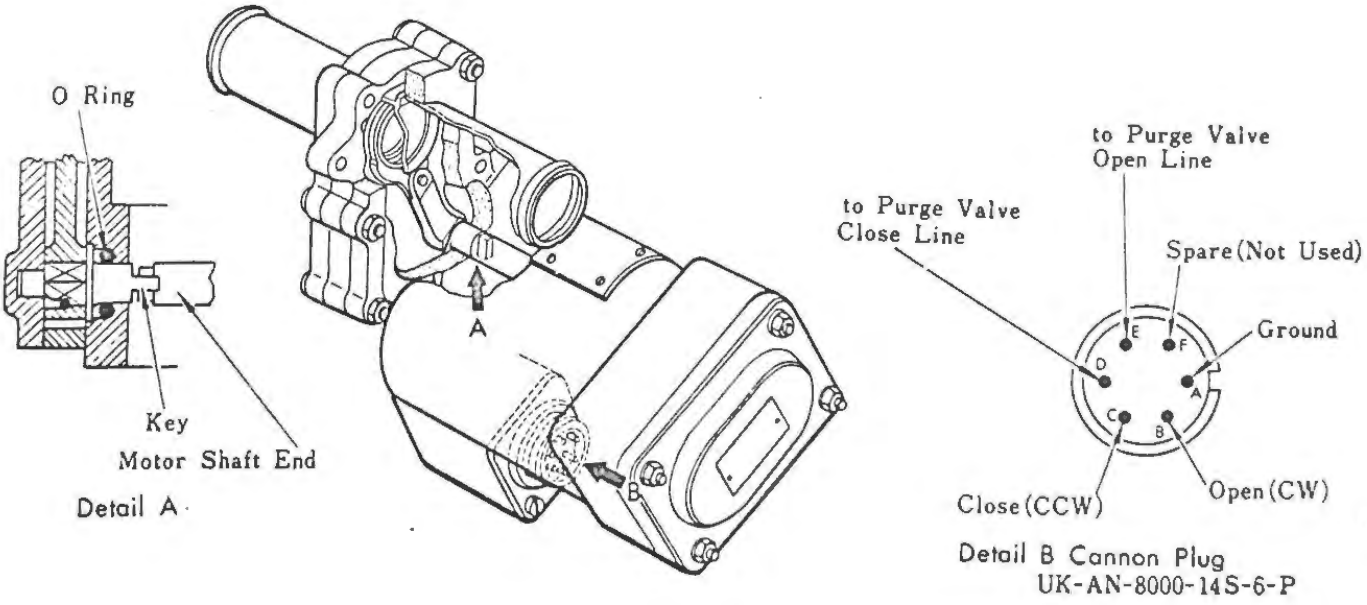


W/M Non-Return Valves

Figure 5–45



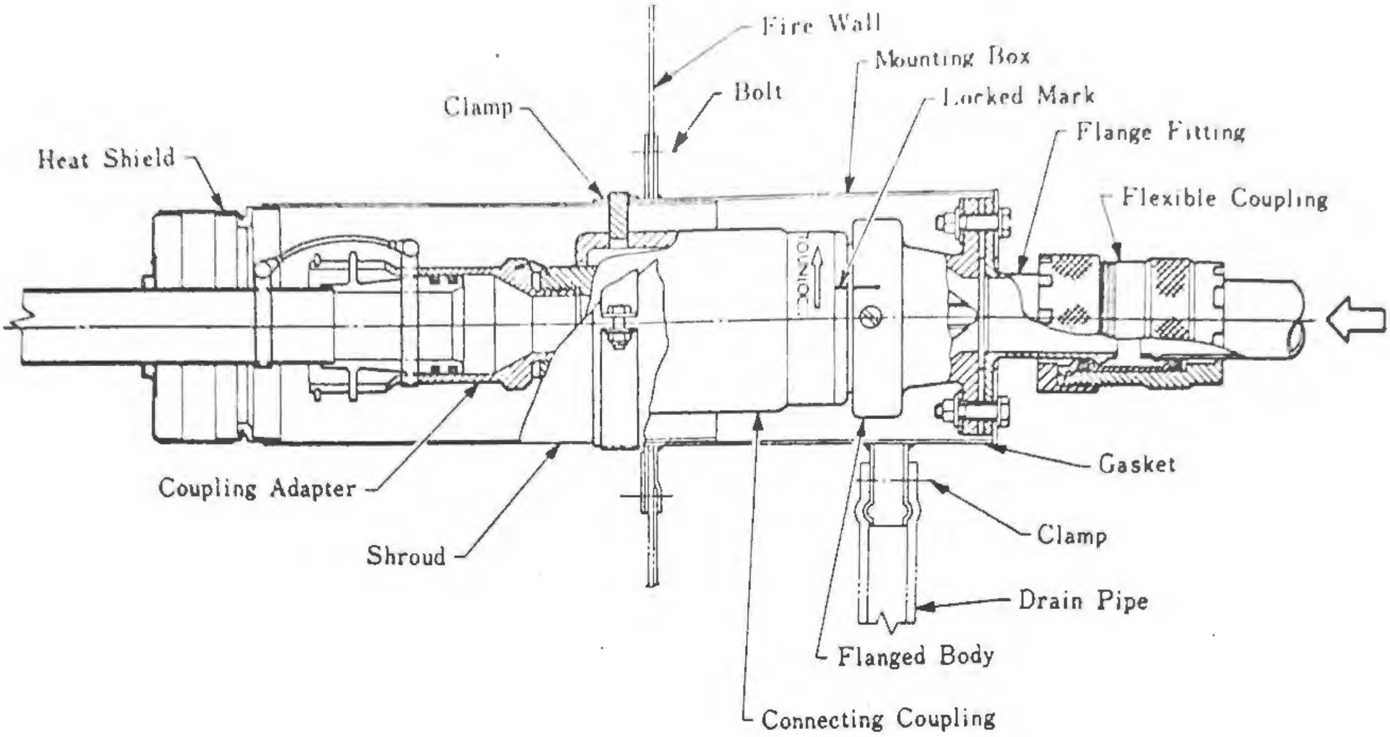
Installation of W/M Shut-off Valve

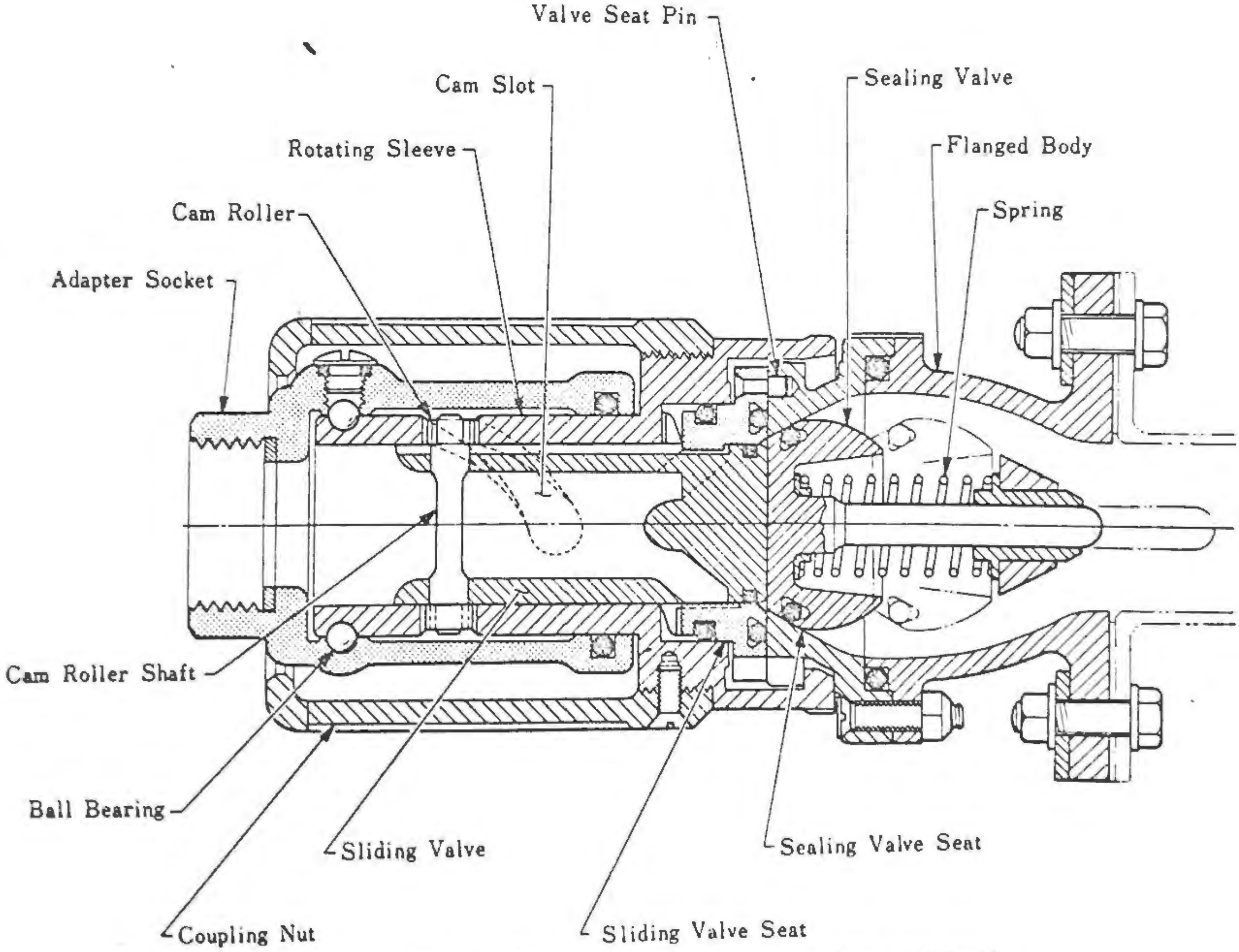


Detail A

Detail B Cannon Plug
UK-AN-8000-14S-6-P

W/M Shut off Valve Assembly
Figure 5–46

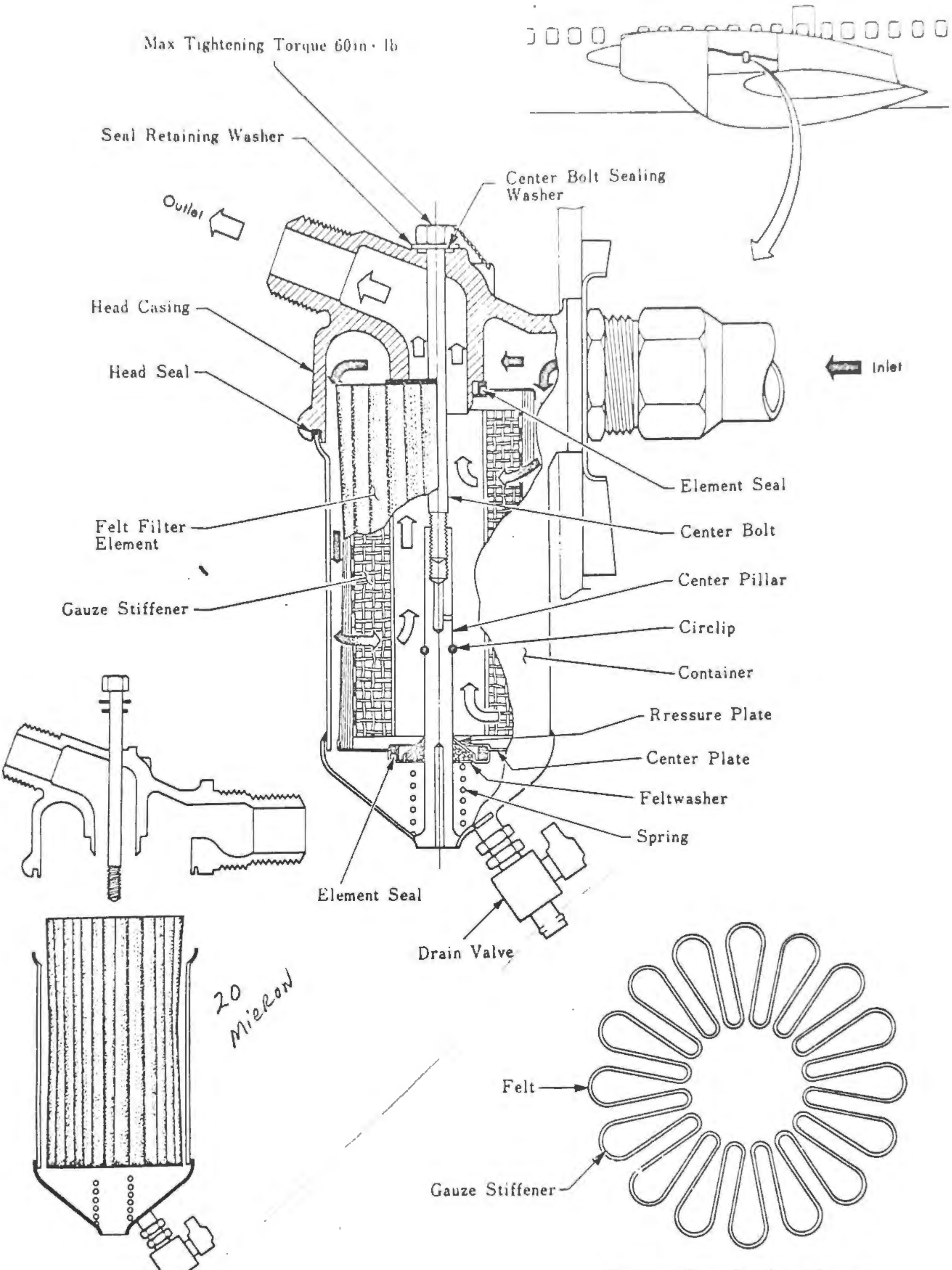




Self Sealing Coupling Cross Section View (Unlock)

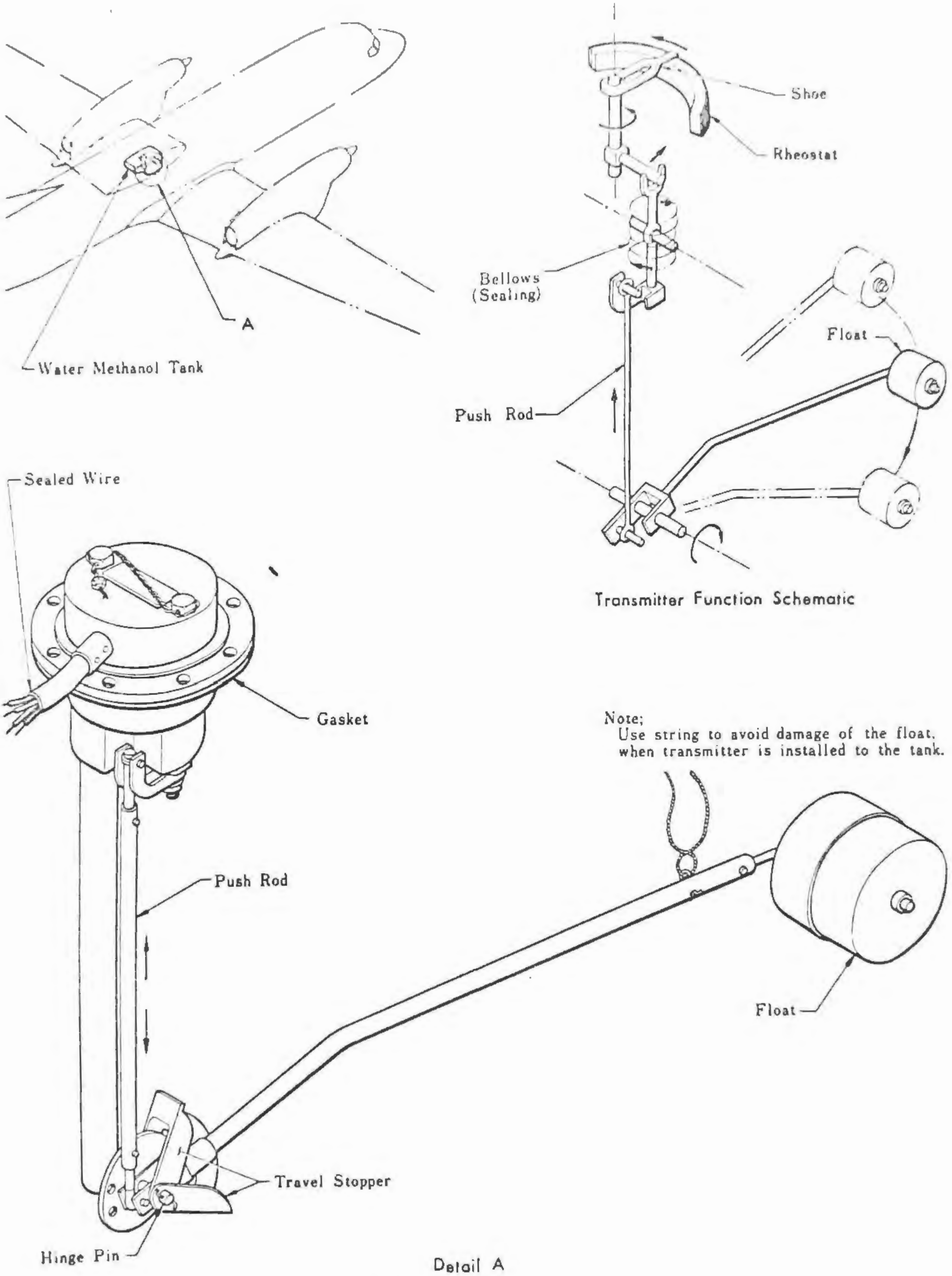
W/M Fire Wall Connection

Figure 5–47



Section Through Filter Element

W/M Filter
Figure 5–48



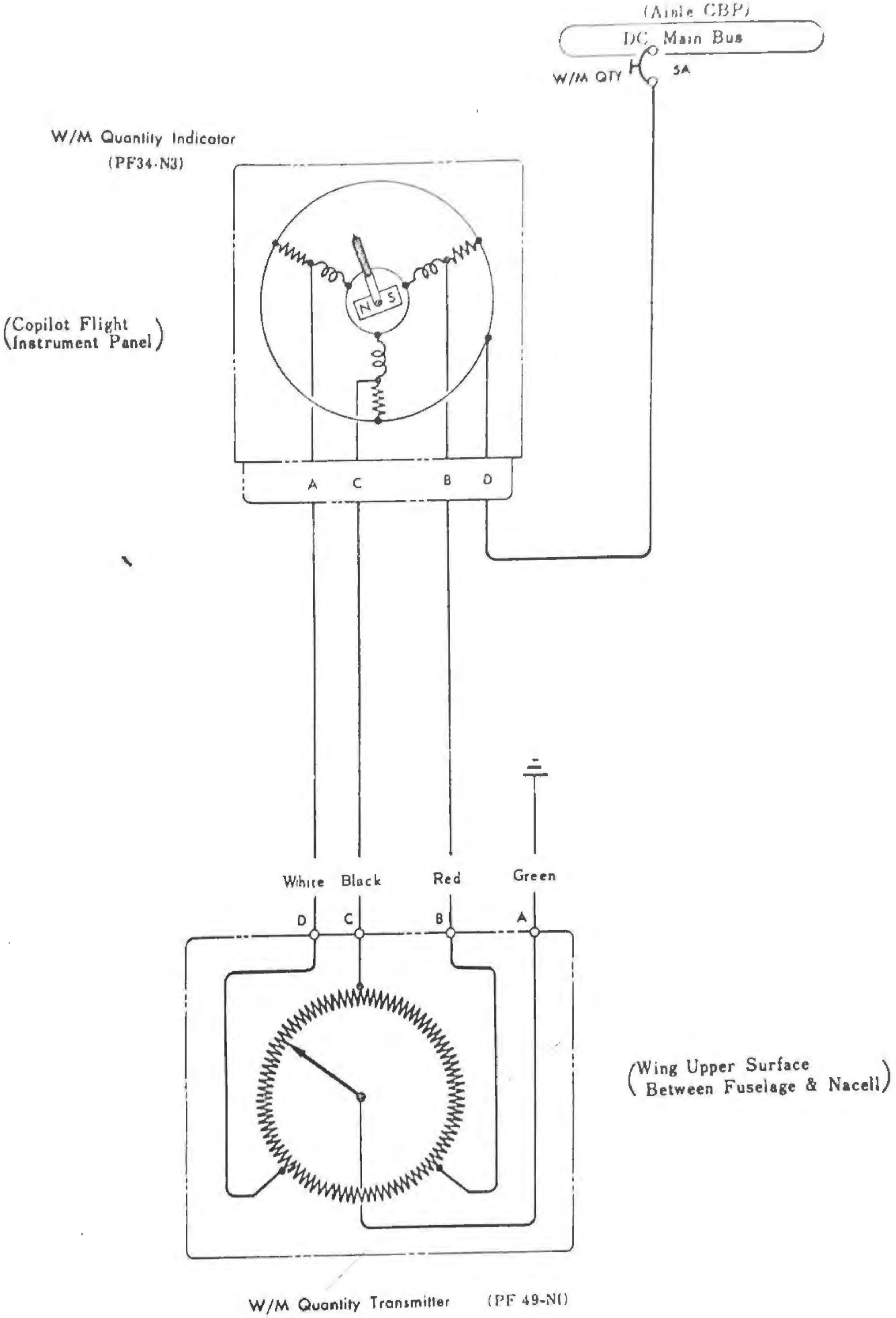
Transmitter Function Schematic

Note;
Use string to avoid damage of the float, when transmitter is installed to the tank.

Detail A

W/M Quantity Transmitter

Figure 5–49



W/M Quantity Indicating System Schematic
Figure 5–50

5.9.8 Water/Methanol Pressure Refueling (Fig. 5-51, Fig. [illegible]

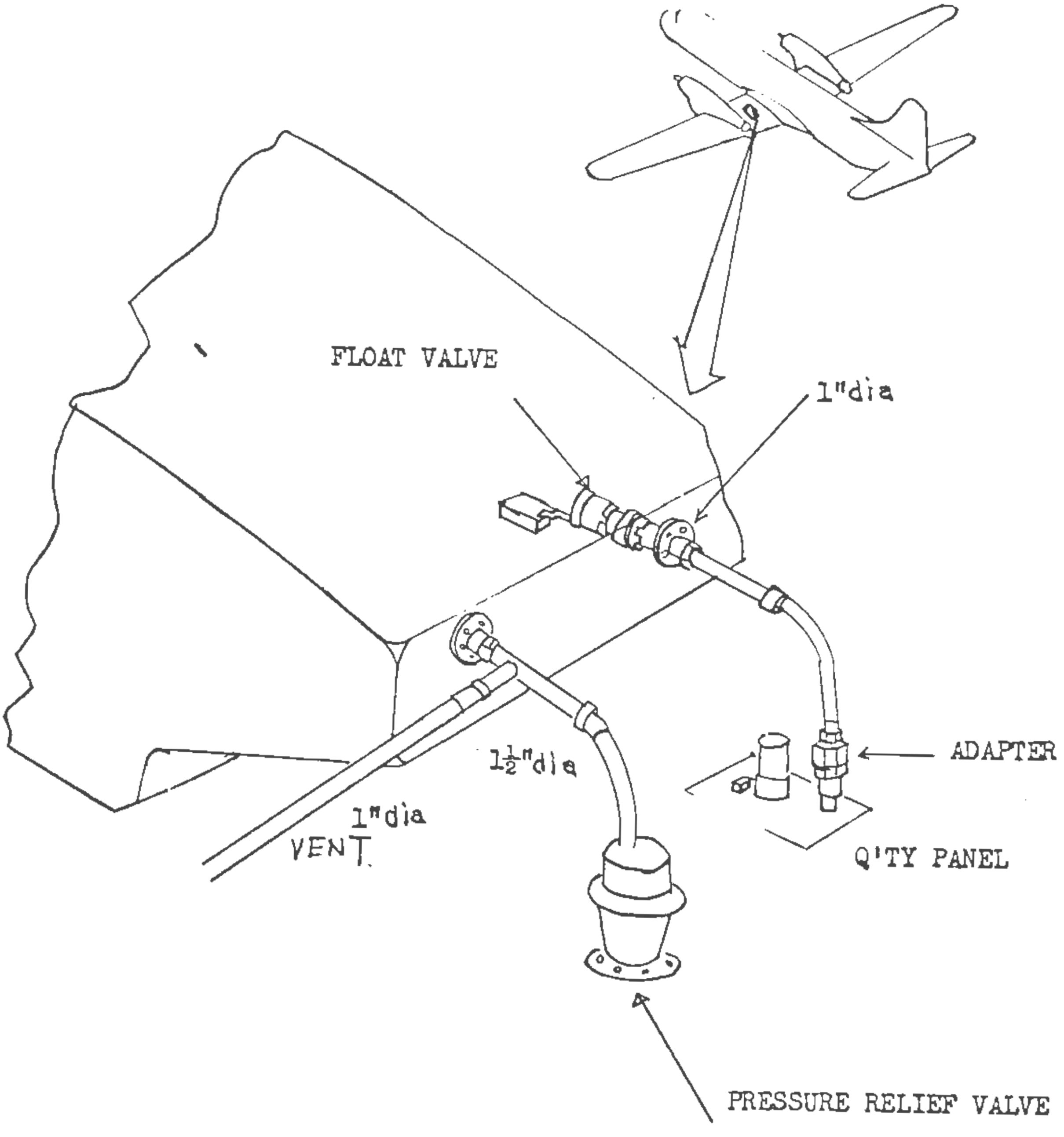
NOTE: The description of this system has been prepared for International use only since its applicability has not been established yet.

The W/M pressure refueling taking place of the present grøvity refueling, supplying W/M from the lower surface of the wing under pressure.

The pressure line uses 1"ø pipe and an adapter is provided on the lower surface of the wing.

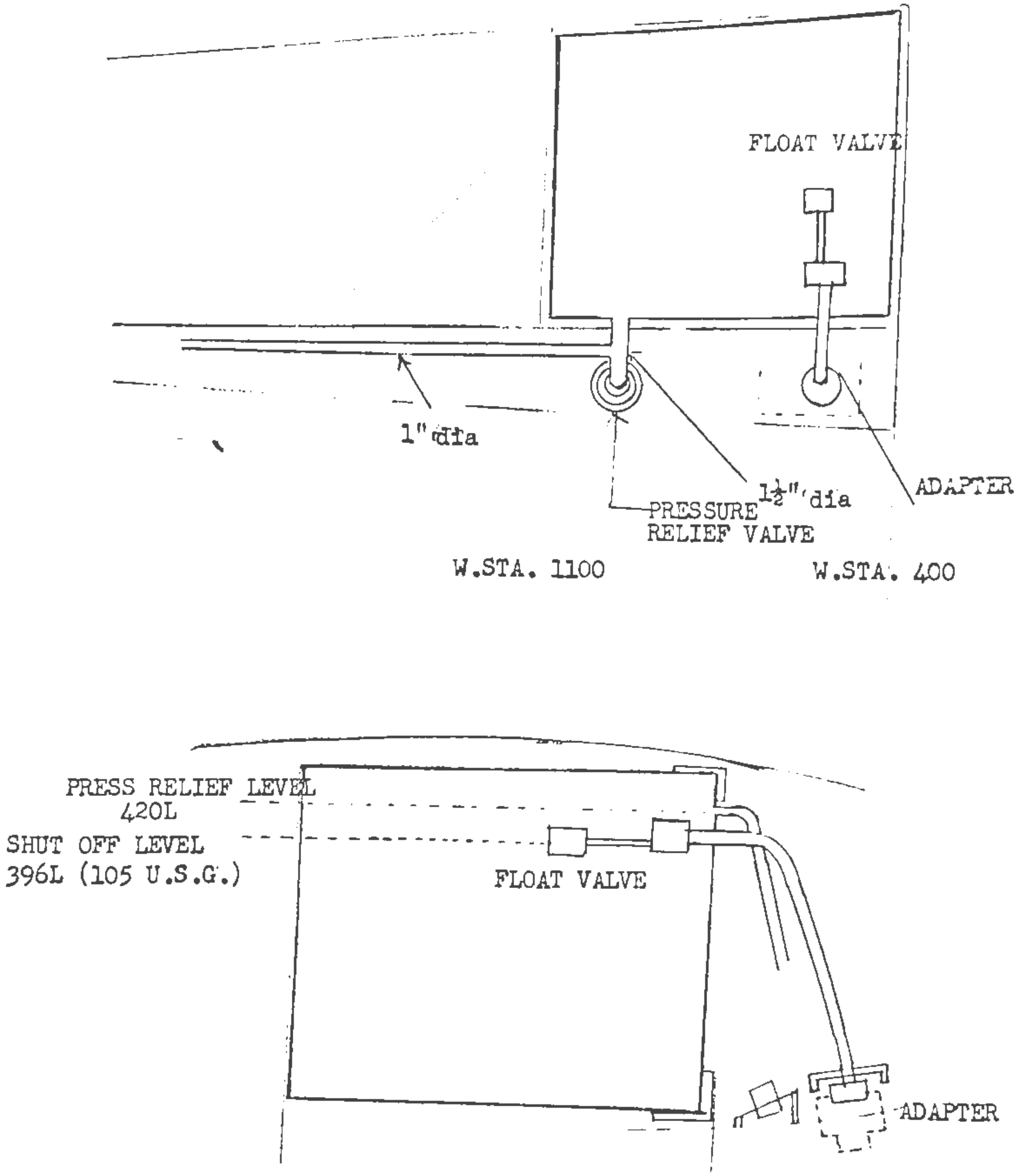
On the panel are provided the quantity indicator, its changeover switch and illuminating lights. A float valve is provided in the tank to shut off W/M supply from the adapter automatically if it reaches a certain level.
Also, in the vent line (1 1/2" ø) is located the same pressure relief valve as that used in the integral tank, to relieve the tank pressure at the opening pressure of 1.75 to 1.5 psi.

Pressure Refueling Level ... 396ℓ (Approx. 105 U.S.G.) when the flow was shut off.
Gravity " 111 U.S.G.
Pressure Relief Level ... 420ℓ
Maximum Refueling Pressure . 25 psi ... 25 U.S.G./Min.



WATER/METHANOL PRESSURE REFUELING SCHEMATIC

Figure 5-51



WATER/METHANOL PRESSURE REFUELING SCHEMATIC

Figure 5-52

Chapter 6 POWER PLANT OPERATION

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Chapter 6 POWER PLANT OPERATION

6.1 Operating Limitations

These limitations are the maximum that have been approved by the Airworthiness Authorities and are in conformity to the requirements of the engine certification tests.
The table given below does not show the optimum climbing and cruising conditions, which are given later.
Whenever the Operating Limitations are exceeded, records should be made and reported.

Condition		R.P.M.	Max. T.G.T. °C	Time Limit
Start			930	Momentary
Static ground idling		8,250 ± 250	600	Unrestricted
Take-off	With water/methanol	15,000	890	5 min.
	Without water/methanol	15,000	865	
Max. continuous		15,000	890	Unrestricted
		15,000 ~ 14,200	820	Unrestricted
		14,200 ~ 13,000	800	
		13,000 ~ 12,500	770	
		12,500 ~	735	
Min. approach		11,000	-	Unrestricted
Overspeed		16,500 Max.	-	20 sec.

NOTE: Ground idling at sea level static conditions, with the fuel datum trimmer at full increase, is determined by the fuel flow of 197.6 ± 3.79 ℓ /hr. (52.2 ± 1 US gal/hr.) [154.2 ± 2.95 kg/hr (340 ± 6.5 lb/hr)]. In this case, the engine speed becomes 7,500 to 8,500 r.p.m.

Maximum atmospheric temperature for engine running

ISA + 30°C

Oil pressure

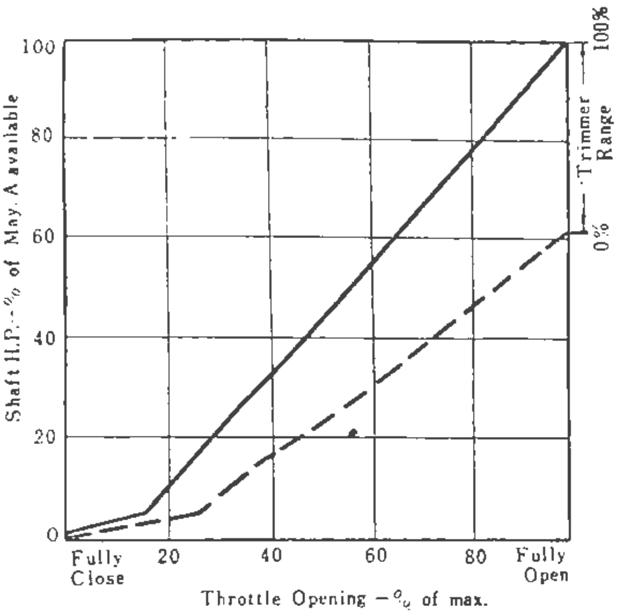
Minimum permissible value: 14 psi at oil temperature of 120°C and maximum continuous speed.

Minimum value for flight: 9 psi at all engine speeds.

Oil temperatures

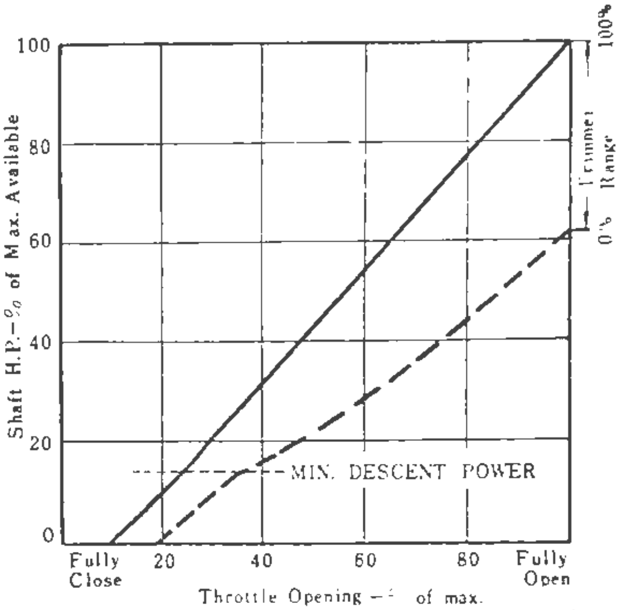
Maximum: 120°C

Minimum for starting:: -30°C



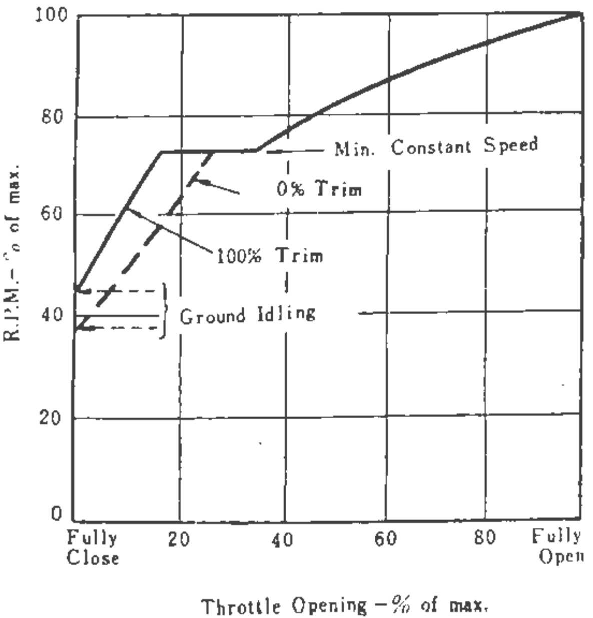
Variation of Shaft Horsepower (Static)

Fig 6 – 1



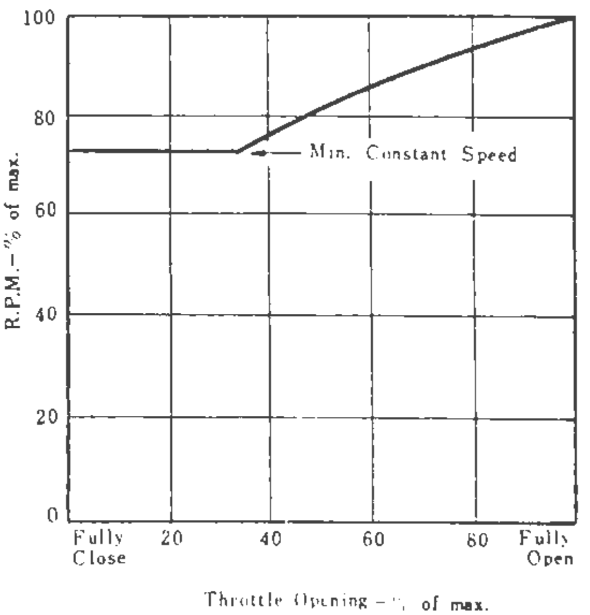
Variation of Shaft Horsepower (In Flight)

Fig 6 – 2



Variation of R.P.m. (Static)

Fig 6 – 3



Variation of R.P.M. (In flight)

Fig 6 – 4

6.2.3.2 Take-off and Initial Climb

Each engine is trimmed individually in accordance with the fuel datum position table (Fig. 6-5), prior to commencing take-off. This ensure that the engine will develop an appropriate power for take-off and initial climb within the T.G.T. limits even when the throttle is fully opened.

6.2.3.3 Climb and Cruise

During Climb and Cruise, the fuel trimmer should be used to maintain the T.G.T. within the recommended conditions irrespective of the outside air temperature. Due to the relationship between the take-off trim requirements and the optimum climb and cruise conditions, it is necessary to trim back fuel immediately after engine speed has been switched from take-off power to climb power. Also during climb, retrimming should be accomplished so that the T.G.T. does not exceed its limits as the altitude increases.

6.2.3.4 Descent

During ordinary descent, the engine torque pressure is around 100 psi; however, when power is further decreased, limitations on minimum power, i.e., 40 psi torque pressure, must be observed in order to ensure positive loading on the reduction gear layshaft. There are various combinations of throttle and fuel datum timmer setting to attain this power setting.

6.2.3.5 Approach and Landing

During approach, the fuel datum trimmer is set to a value obtained from the fuel datum position table (Fig. 6-5), using prevailing temperature and pressure altitude at the destination airfield obtained from the control tower, so that appropriate engine power within the T.G.T. limitations will be available for go-around. The T.G.T. limitations set for engine speeds should never be exceeded even when the fuel trimmer is set during approach as stated above.

6.2.3.6 Note

When setting the fuel datum trim position for take-off and landing, the fuel datum trimmer should always be moved from "decrease" side to obtain the same setting.
Whenever the T.G.T. exceeds the limitation, operate the fuel datum trimmer at any time to lower the T.G.T.
Since there is a time lag between fuel trimmer operation and T.G.T. indication, be careful not to overshoot T.G.T. when operating the fuel trimmer by watching the T.G.T. indicator.

6.2.4 Propeller Synchronizer

The system has a maximum synchronizing range of approximately ±350 r.p.m. However, since this maximum value varies with the engine speeds, it is desirable to use the synchronizer after adjusting the number of revolutions of both propellers as much as possible. In general, the propeller synchronizer is used after adjusting the speed to less than ±250 r.p.m.

AMBIENT TEMPERATURE (deg. C.)	-1,000	-500	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000	AMBIENT TEMPERATURE (deg. C.)
+51	52																		+51
+49	55	48	46																+49
+47	58	51	49	44															+47
+45	61	53	51	46	41														+45
+43	64	56	54	49	44	39													+43
+41	67	59	57	52	46	42	37												+41
+39	70	62	60	55	49	45	40	35											+39
+37	73	65	63	58	52	47	43	38	33										+37
+35	76	69	66	61	55	50	45	40	36	32									+35
+33	80	72	69	64	58	53	48	43	39	35	31								+33
+31	83	75	72	67	61	56	51	46	41	38	34	30							+31
+29	86	79	75	70	65	59	55	49	44	40	36	33	29						+29
+27	90	82	79	73	68	62	58	52	47	43	39	36	32	29					+27
+25	93	85	82	77	71	66	61	55	51	46	42	39	34	31	28				+25
+23	97	89	85	80	74	69	64	59	54	49	45	42	37	34	30	27			+23
+21	100	92	89	83	78	72	68	62	57	53	48	45	40	37	33	30	26		+21
+19		96	93	87	81	76	71	65	61	56	52	48	43	40	36	32	29	25	+19
+17		99	96	91	85	79	75	69	64	60	55	51	46	43	39	35	31	28	+17
+15		100	100	94	89	83	78	72	68	63	59	54	50	46	42	38	34	31	+15
+13				98	92	87	82	76	71	67	62	58	53	49	45	41	37	34	+13
+11				100	96	90	86	80	75	70	66	62	57	53	48	44	40	37	+11
+ 9					100	94	90	84	79	74	70	65	60	56	52	48	44	40	+ 9
+ 7						98	94	88	83	78	73	69	64	60	56	51	47	43	+ 7
+ 5						100	98	92	87	82	77	73	68	64	59	55	50	46	+ 5
+ 3							100	96	91	86	82	77	72	68	63	59	54	50	+ 3
+ 1								100	95	90	86	81	76	72	67	62	58	54	+ 1
- 1									99	94	90	85	80	76	71	66	62	58	- 1
- 3									100	99	94	89	84	80	75	70	66	62	- 3
- 5										100	99	93	89	84	79	74	70	66	- 5
- 7											100	98	93	89	84	78	74	70	- 7
- 9												100	98	93	88	83	79	74	- 9
-11													100	98	93	87	83	79	-11
-13														100	97	92	88	83	-13
-15															100	97	93	88	-15
-17																100	97	93	-17
-19																	100	98	-19
-21																		100	-21

Engine power checks should not be carried out in ambient conditions denoted by this area of the table

FULL INCREASE

PRESSURE ALTITUDE (ft.)

01824

Fuel datum position (tabular)

Fig. 6-5

Because of the operational characteristics of this mechanism, it is only effective when the throttles are within the constant speed range.
When the throttle levers are selecting minimum constant speed, the r.p.m is determined solely by the P.C.U. and the synchronizer is inoperative.
The system will again become effective when the throttles are open beyond this point.
Since actual engine speeds are the same when the synchronizer is operating, an error in the engine speed indicator system will be immediately discovered.
When this error is compartively great, it is recommended to set both engine speeds so that the mean indicated speed will be that required. During climb and cruise, a tolerance of +100 r.p.m. is permitted for the required mean speed.
The synchronizer must be switched off during take-off and landing. If not, the slave engine speed will be affected in the event of a trouble with the master engine.
Should a propeller be feathered in flight, the synchronizer should be switched off.
If r.p.m. has varied, or if it fluctuates, switch off the synchronizer and reset it.

6.3 Recommended Operating Condition

The following operating conditions are the maximum recommended for all scheduled flights. However, where circumstances permit, the engine life will be improved by the use of conditions below the recommended maximum.

6.3.1 Recommended Conditions

(1) Normal climb power

14,200 r.p.m. T.G.T. 770°C

(2) Cruise and cruise climb power

14,200 r.p.m. T.G.T. 770°C

(3) Operationally essential power

14,500 r.p.m. T.G.T. 770°C

6.3.2 Alternative Conditions

To improve turbine blade reliability, a lower climb and cruise power may be used.
Whenever necessary, the following powers are recommended for use at the operator's discretion.

(1) Normal climb power

14,200 r.p.m. T.G.T. 745°C

(2) Cruise and cruise climb power

14,200 r.p.m. T.G.T. 745°C

(3) Low power cruise

14,200 ~ 14,000 r.p.m.	T.G.T. 745°C
14,000 ~ 13,000 r.p.m.	T.G.T. 700°C
13,000 ~ 12,500 r.p.m.	T.G.T. 675°C

6.3.3 Operationally Essential Power and Emergency

It should be noted that the maximum power for use in an emergency or simulated emergency is the maximum continuous power of the engine, i.e., 15,000 r.p.m. with T.G.T. 990°C. However, occasions will arise when it is required to use more than the normal climb or cruise power, but less than maximum continuous power; in this event, operationally essential power should be used.
The duration and reason for the use of either maximum continuous or operationally essential power must be recorded in the aircraft maintenance log. Occasions when operationally essential power may be used are as follows.

(1) When additional climb power is temporarily required to reach a new altitude from the initial scheduled altitude.

(2) When severe turbulence exists at the flight altitude and higher altitude above such turbulence is desired.

(3) When additional climb power is temporarily required to obtain satisfactory clearance over high terrain at high ambient temperatures.

(4) When Air Traffic requirements insist on a time limit for the attainment of the minimum scheduled altitude.

(5) In the event of a trouble with one engine.

6.4 Operating Data

6.4.1 Power Setting Procedure

The fuel trimmer should be used to obtain the recommended T.G.T. However, at extremely high ambient temperatures, the fuel trimmer range may be inadequate. In such a case, the speed should be left at the selected value, and with the fuel datum trimmer at full decrease, the T.G.T. may be allowed to rise to the maximum figure, associated with the selected speed.
To adjust engine power in flight, it is recommended that the following sequence be observed.

(1) Select the required speed.

(2) Trim the fuel to the optimum T.G.T.

There are various methods for obtaining a certain power by changing the engine speeds and the T.G.T. Any method may be adopted so far as the limitations are not exceeded. But, for longer engine life, it is recommended to adopt a high speed and low T.G.T. (Fig. 6-6) Accordingly, to decrease the power, decrease the fuel trimmer to lower the T.G.T. and then the r.p.m.; contrarily, to increase the power, raise the r.p.m. and then increase the fuel trimmer.

6.4.2 Oil Pressure

Oil pressure at take-off speed, 15,000 r.p.m., should be within 15 to 30 psi. If a pressure less than 15 psi is indicated, the following check should be made at 12,000 r.p.m.

Minimum oil pressure at 12,000 r.p.m.:

13.5 psi at 55°C } and the pressure changes linearly between
12 psi at 120°C } 55°C and 120°C.
13.5 psi at -15 to + 55°C

A check must be made to make sure that the oil pressure is above the minimum limit as soon as possible if oil temperature is above 55°C in flight.
The low oil pressure warning light will come on when the oil pressure falls below 5 to 6 psi.
The low oil pressure warning light may flicker during violent maneuvers or in extreme turbulence and may also flicker momentarily on withdrawal of the flight fine pitch stop on landing.

6.4.3 Oil Temperature

The minimum oil temperature at the time of engine start is -30°C. External heating is necessary in case the temperature is below this value.
If the oil temperature is less than -15°C after starting the engine, the engine should be idled until this temperature is reached. It is permissible to run the engine at the minimum constant speed for warm-up because it takes about 3 minutes at the minimum constant speed to warm up from the minimum starting temperature to the opening-up temperature.
Minimum oil temperature for internal power starting is -10°C.

6.4.4 Feathering Warning

The throttle lever, if opened abruptly, exceeds 12,800 r.p.m., before torque pressure reaches 50 psi, thus actuating auto feather mechanism. In such a event, the automatic feathering system will coarsen the propeller pitch until the torque pressure rises above 50 psi. This process takes a very short time and does, in effect, assist acceleration. The feathering pump warning light will come on during this brief cycle.

6.4.5 Excessive T.G.T.

Whenever the T.G.T. limit value is exceeded, a proper operation must be carried out to lower the T.G.T.
Whenever the maximum T.G.T. is exceeded, such events should be recorded and reported together with the duration and degree of the excess. If a remedial action is found ineffective, the propeller must be feathered in flight or the H.P. cock must be closed on the ground.
If the following condition is exceeded, feathering action should be taken.

5 seconds at 950°C	for momentary rise only; this feathering is not needed when the temperature does not exceed 950°C.

NOTE: During starting operation, the T.G.T. limitation of 930°C must not be exceeded.

.4.6 Torque Meter Indication

An irregular indication of the torque meter indicates the engine is malfunctioning. In such a case, the propeller shall be feathered or some other proper action shall be taken.
If the indicator pointer swings between the normal value to zero repeatedly and quickly, the transmitter is malfunctioning. In this case, the power setting should be altered to reduce 40 to 50 psi. If the transmitter is malfunctioning, the fluctuation will stop. Therefore if all other indications are normal, the power should be reset to the original setting and no further action is required to be taken. Flight may be continued.

6.4.7 Complete Electrical Failure

Those which have direct influence upon the engine in case of complete electrical failure are as follows.

(1) Fuel booster pump failure

To prevent the occurrence of engine fuel pump inlet cavitation, altitude and fuel flows should be reduced to their practicable minima to ensure the continued operation of the airplane.
Generally, the less the fuel is, the more often cavitation takes place.

(2) Propeller low stop failure

In the event of a complete electrical failure, the engine should be stopped as soon as practicable after landing to prevent engine overheating because the propeller flight fine pitch stop is engaged. During this process, be sure not to open the throttles.

6.4.8 Water/Methanol

The use of water/methanol for take-off or in flight is restricted to ambient air temperatures of -20°C to I.S.A. +30°C, and up to an altitude of 15,000 feet.
The water/methanol system should not be operated at 14,500 r.p.m. or over. If its use is needed in such a case, decrease the engine speed once to less than 14,500 r.p.m. and after setting the water/methanol system, open the throttles fully.

6.4.9 Negative "G" Flight

Negative "G" flight should be avoided wherever possible. However, if sustained negative "G" flight is encountered, it is advisable to close both throttles until normal flight is resumed and normal oil pressure is obtained. This aims to prevent the auto-feathering circuit from being energized by the momentary decrease of the oil pressure going into the torque meter system.

6.4.10. Simulated Auto-Feather

When auto-feathering is required for training or tests, observe the following items.

6.7 In-Flight Operation

6.7.1 Take-off and Power Check

The airplane take-off shall be performed in accordance with the prescribed check list.

CAUTION: IF THE THROTTLES HAVE BEEN RETARDED BELOW 13,000 R.P.M. ON THE GROUND, THE FINE PITCH STOP LEVER, IN ANY CASE, MUST BE RETURNED TO THE GROUND POSITION DURING TAKE-OFF.

Engine power shall be checked during take-off.
T.G.T. indications of power show a lag during the early stages of take-off with dry power. When engines are developing wet power, T.G.T. has nothing to do with engine power. The fuel trimmer position set before take off, not be changed unless T.G.T. exceeds the limitation.
The pilot must make sure that engine is developing sufficient power during take-off, noting the following;

(1) With water/methanol (wet power)

Indicated torque pressure, after altitude correction, shall be within -10 psi to +25 psi of the water/methanol check pressure (W.M.C.P.).

A. W.M.C.P. has been specified for each engine; namely it is steady at the ambient air temperatures between -20°C and ISA +30°C and up to the pressure altitude of 15,000'.

B. The altitude correction is ±3 psi for every 1,000 feet up to 8,000 feet, added to the indicated torque pressure if above sea level, and subtracted if below sea level and 6 psi for every 1,000 feet above 8,000 feet.

C. Torque pressure tends to overshoot in the initial stage of take-off with water/methanol. This should exceed 75 psi in about 5 seconds and should then stabilize within the water/methanol check pressure tolerance given above.

D. Do not select water/methanol at engine speeds higher than 14,500 r.p.m.

(2) Without water/methanol (dry power)

Indicated torque pressure, after altitude correction, shall be within -45 psi to +20 psi of the engine power check pressure (E.P.C.P.) within 10 seconds after reaching 15,000 r.p.m.

A. E.P.C.P. has been specified for each engine, and increases or decreases at the ratio shown in Fig. 6-8, depending on the ambient air temperature and pressure altitude. A typical example is given in Fig. 6-9.

B. The altitude correction is 5 psi for every 1,000 feet, added to the indicated torque pressure if above sea level, and substracted if below sea level.

Engine power checks should not be carried out in ambient conditions in excess of I.S.A. +35 deg. C.

NO CORRECTION

AMBIENT TEMPERATURE (deg.C.)	-1,000	-500	S.L.	+1,000	+2,000	+3,000	+4,000	+5,000	+6,000	+7,000	+8,000	+9,000	+10,000	+11,000	+12,000	+13,000	+14,000	+15,000	AMBIENT TEMPERATURE (deg.C.)
+21	0																		+21
+19	3																		+19
+17	9	0																	+17
+15	16	6	0																+15
+13	22	12	5	0															+13
+11	28	18	12	3															+11
+ 9	34	24	18	10	0														+ 9
+ 7	40	30	24	16	7	0													+ 7
+ 5	46	36	30	22	13	4	0												+ 5
+ 3	52	43	36	28	20	10	2												+ 3
+ 1	58	49	42	34	26	17	8	0											+ 1
- 1	64	55	18	40	32	23	14	7	0										- 1
- 3	70	60	54	46	38	29	21	13	6	0									- 3
- 5	76	66	60	52	44	35	27	20	12	5	0								- 5
- 7	81	72	66	58	49	41	33	26	19	11	5	0							- 7
- 9	87	78	72	64	55	47	39	32	25	18	11	4	0						- 9
-11	92	83	79	69	61	53	45	38	31	24	17	10	4	0					-11
-13	98	89	83	74	66	58	51	44	37	30	23	16	10	3	0				-13
-15	104	94	88	80	72	64	56	50	43	36	29	23	16	9	3	0			-15
-17	109	100	94	86	78	70	62	55	48	41	35	29	23	16	10	3	0		-17
-19	114	105	99	91	83	75	68	61	54	47	41	34	29	22	16	9	3	0	-19
-21	120	111	104	96	88	81	73	66	59	52	46	40	34	28	22	16	9	3	-21
-23	126	116	110	102	94	86	79	72	64	58	52	46	40	34	28	22	16	10	-23
-25			115	107	99	92	84	77	70	63	57	51	46	40	34	28	22	16	-25
-27					104	97	90	82	75	68	62	56	51	45	40	34	28	23	-27
-29							95	87	80	73	68	62	56	50	46	40	34	29	-29
-31								91	84	78	72	66	61	56	51	46	40	35	-31
-33										83	77	72	66	61	56	51	46	41	-33
-35												76	71	66	61	56	51	47	-35
-37															66	61	56	52	-37
-39																		57	-39

PRESSURE ALTITUDE (ft.)

G1746

NOTE: Subtract the correction value obtained from this table from the appropriate T.G.T. limitation

T.G.T. corrections at 15,000 r.p.m. (tabular)

Fig. 6-10

3. Whenever the relight switch is used, the events should be recorded and reported.

6.8.1.4 Engine De-icing System Failures

(1) If a red fail light comes on:

Engine de-ice master switch	OFF; then, ON

If fail light remains on:

Alternator power source	Check; reset if necessary

If the alternator is normal but the de-icing circuit is found defective;

Engine de-ice master switch	OFF

If icing condition persists with faulty engine de-icing:

Relight switch	ON

(2) If an amber timer fail light comes on:

Engine de-ice master switch	To be left ON

If red fail light comes on:

Engine de-ice master switch	OFF

If icing condition persists:

Relight switch	ON

(3) If the fail light (red) comes on due to the failure of the alternator,

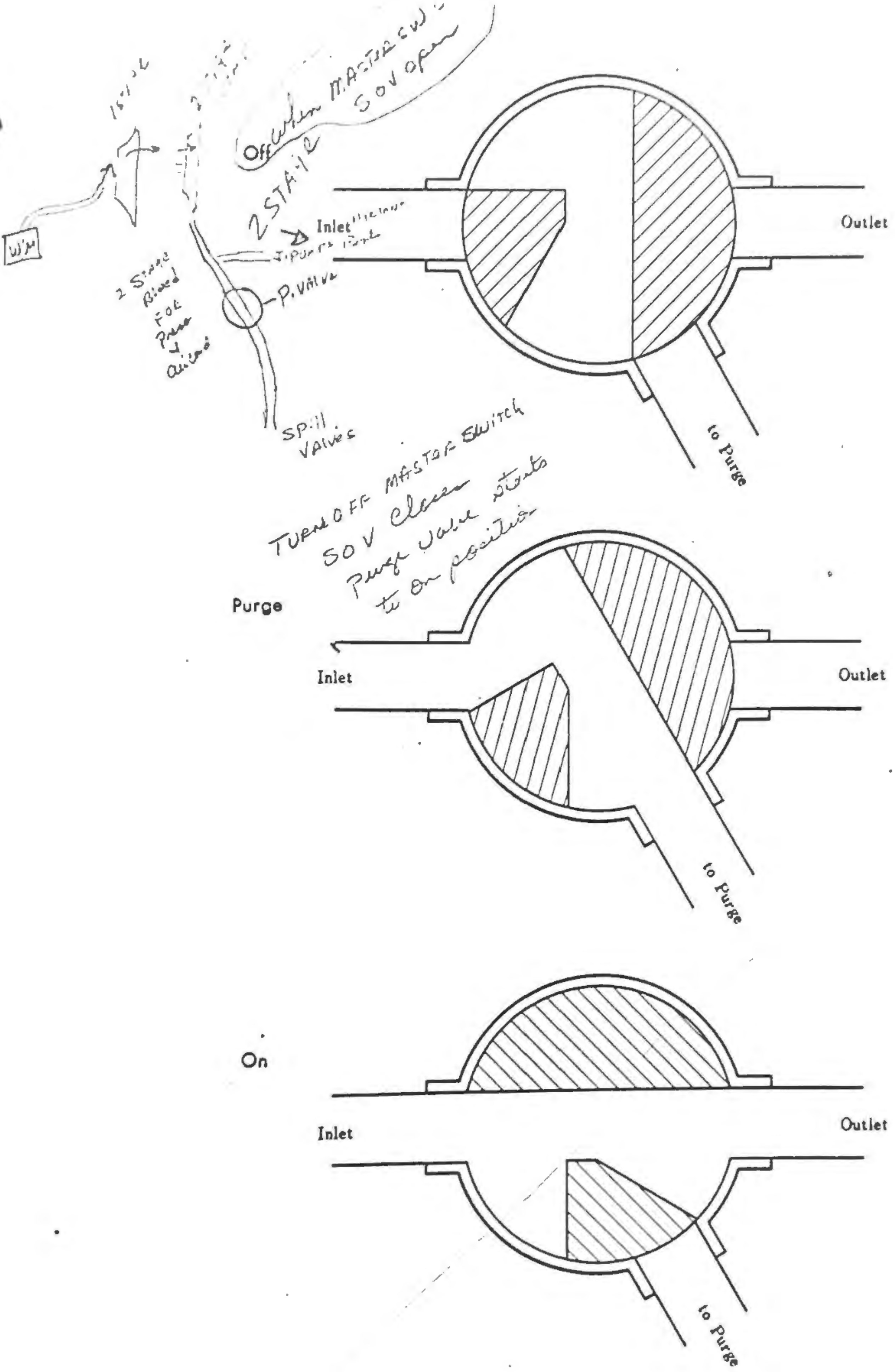
Engine de-ice master switch	OFF
Failed alternator switch	OFF

In case that the engine de-ice crossfeed system has been installed,

Alternator transfer switch	TRANSFER
Engine de-ice master switch	ON

CAUTION: IN THIS CASE, DO NOT USE THE GALLEY HEATER.

CAUTION: WHEN EITHER THE DE-ICE FAIL LIGHT OR THE TIMER FAIL LIGHT COMES ON, EXCESSIVE PROPELLER VIBRATIONS OR ENGINE MALFUNCTION MAY RESULT, NECESSITATING STOPPING THE ENGINES.



Off when MASTER SW & SOV open

2 STAGE → Inlet

TURN OFF MASTER SWITCH SOV Closes Purge Valve starts to On position

Purge Valve Position
Figure 5–42

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Minimum for starting by internal batteries: -10°C

Minimum for opening up: -15°C

6.2 Handling

6.2.1 General

Experiences have shown that, for maximum reliability, longer life with less frequent overhaul, and more economy in operation, the engine power should be kept to a minimum for the operational requirements. The service reliability and ultimate life of the hot section which accounts for a major part of the overhaul costs, are directly affected by turbine temperatures during engine operation. Special emphasis, therefore, should be placed on engine control during Climb and Cruise because these constitute most of the total flight time. Where operating circumstances permit, a rolling take-off technique should be used; the engine power should be checked at the initial stage of taxiing; and the use of take-off power should be kept to a minimum for the engine life.
Details of the maximum recommended operating conditions are given in this chapter, but it should be noted that some are more severe than the limitations mentioned in 6.1 because of the reasons above-mentioned.
Whenever the Operating Limitations are exceeded during engine operation, such events should be reported.
Also, see to it that the fuel supply to the engines will not be short.
If the fuel supply is insufficient, the air may be sucked into the fuel system, causing unstable engine operation. In such a case, the engine power shall be checked prior to flight.

6.2.2 Throttle Operation

Sudden throttle lever operation should be avoided because it will cause high T.G.T. and rapid temperature changes, which affect the engine life. Accordingly throttle lever operation shall be performed as smoothly as possible.
When closing the throttle, the engine speed will drop slightly before settling to the new selected value, and T.G.T. will first rise and then fall gradually to the new selected value corresponding to the engine speed.
Abrupt retarding of throttle during taxiing or in the static condition on the ground, should be avoided to prevent the excess stress in propellers.
Particularly when the engine speeds are within the range from 15,000 r.p.m. to 14,500 r.p.m., throttle lever should be operated cautiously.

6.2.3 Fuel Trimmer

The relationship between the fuel trimmer and the engine power is shown in Figs 6-1 and -2.

6.2.3.1 Engine Start

The optimum fuel flow for engine starting can be obtained with the fuel trimmer at 10% (outside air temperature above 10°C) or 30% (outside air temperature below 10°C) and the throttle fully closed.

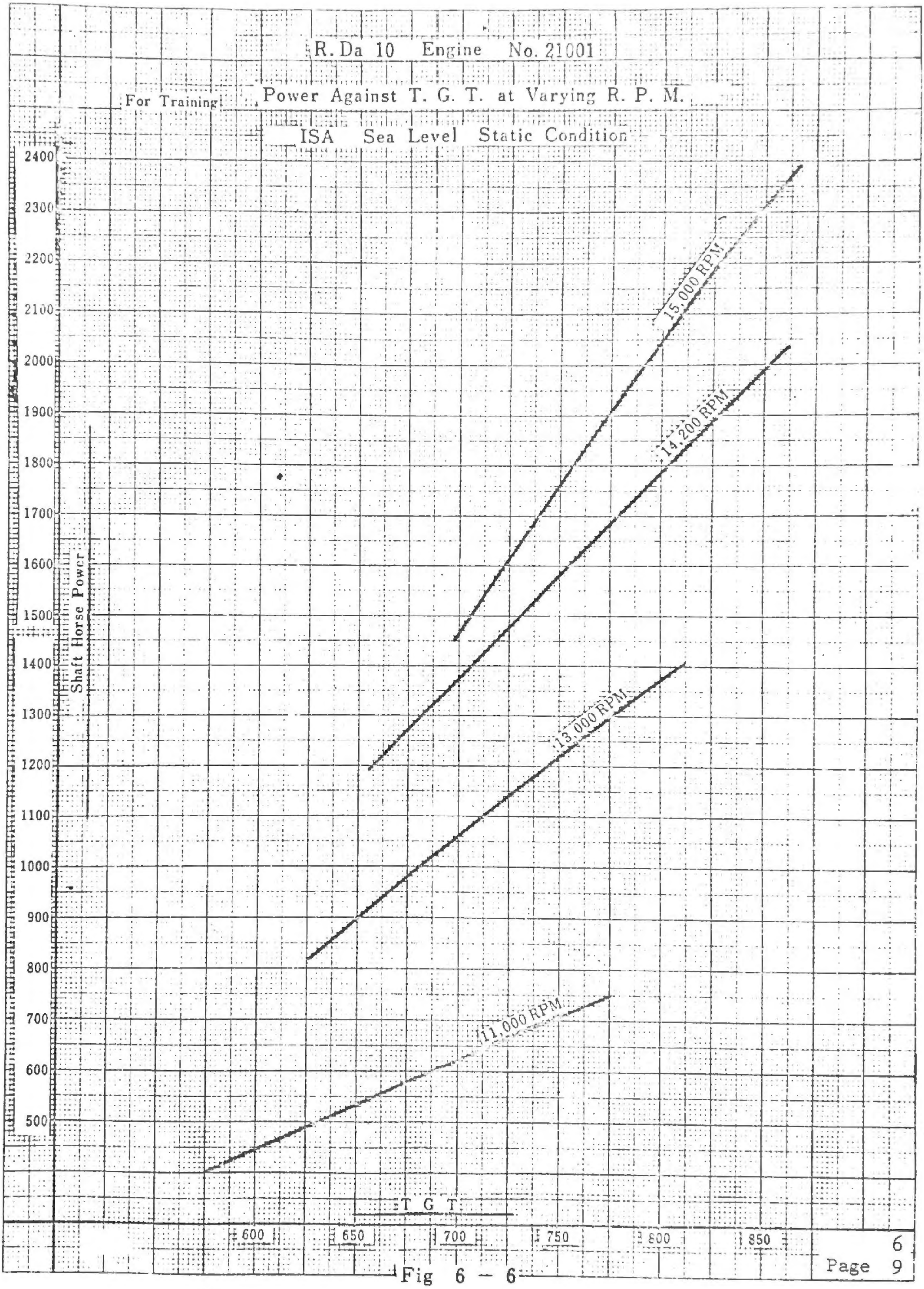

R. Da 10 Engine No. 21001
For Training
Power Against T. G. T. at Varying R. P. M.
ISA Sea Level Static Condition
Shaft Horse Power
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
15,000 RPM
14,200 RPM
13,000 RPM
11,000 RPM
T G T
600
650
700
750
800
850

Fig 6 — 6

(1) The auto-feather override switch must be provided.

Throttle lever	13,500 r.p.m. or higher
Auto-feather override switch	ON
H.P. cock	Fuel OFF

After completion of auto-feathering operation, perform the manual feathering and turn the override switch off.

(2) When no auto-feather override switch is provided, carry out the following operation in the state of Cruise only. (Engines on which Dart Modification 733 has been accomplished.)

Throttle lever	Over 13,500 r.p.m.
L.P. cock (Emergency fuel cock)	CLOSE

After completion of auto-feathering, accomplish manual feathering operation.
In this case, the engines shall be unfeathered within 2 minutes.

(3) Close the H.P. cock and then open the cock, but do not energize the auto-feather circuit.

6.4.11 Items which Affect Engine Power

As previously stated, the engine power is affected by the ambient air temperatures, altitudes and airspeeds. Beside these, what affect the engine power are accessory drive power, fuel heater, and humidity.
The accessory drive is driven by the gear box, for the drive of which the maximum 70HP is required. Among the accessories, the cabin supercharger requires the greatest proportion of the engine power. On take-off, the compressed air from the supercharger must be spilled to reduce load on the supercharger for the purpose of minimizing power loss. The compressed air can be automatically spilled out by opening the throttles fully. Further, power loss can be prevented by stopping supercharger, if circumstances permit, when one engine is feathered in flight.
The fuel heater utilizes the bleed air from the engine compressor; and accordingly the use of the bleed air causes the reduction of the engine power, though slightly. Its proportion is about 4% of power at the engine speed and T.G.T. at that time. Gauge readings in this case indicate a slightly dropped engine torque pressure and a slightly increased T.G.T.
Humidity in the atmosphere affects the engine power, though slightly, on the engine power. With respect to the official engine performance, humidity is expressed in terms of Pw/Po. The prescribed value of humidity is 0.01. If the humidity increases, the engine power decreases slightly.

(Pw: ATMOSPHERIC PRESSURE lbs./in.^{2} ABS
Po: WATER VAPOR PRESSURE lbs./in.^{2} ABS)

The relationship between these pressures is given in Fig. 6-7, which shows effect of humidity upon engine performance. The extent of this effect also varies between take-off power and maximum continuous power. For example,

EFFECT OF HUMIDITY ON PERFORMANCE

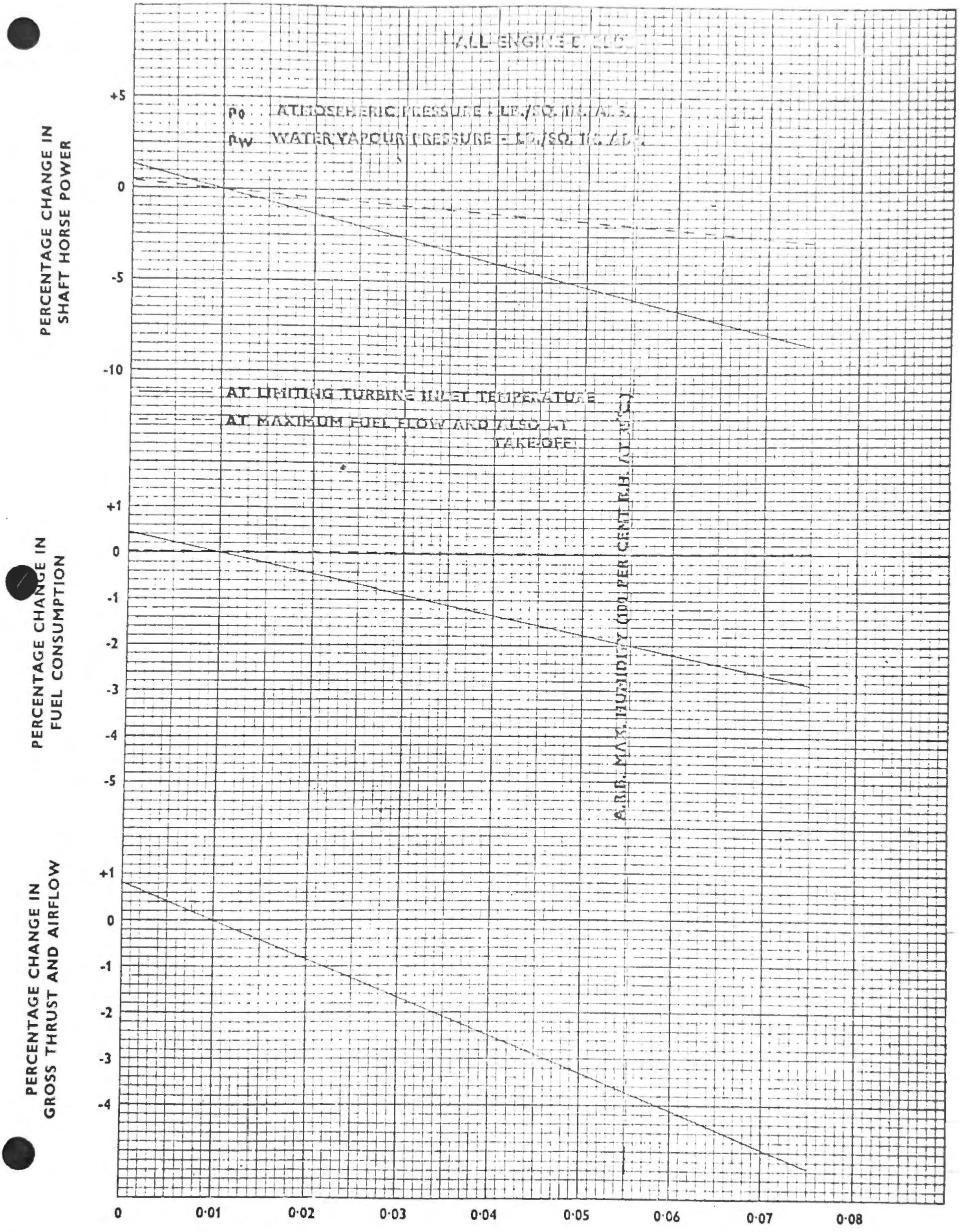


Fig. 6-7

take-off power decreases 2% and the maximum continuous power, about 6%, when the ambient air temperature is 35°C and the humidity is 100%. This is true only is the case of dry power; and accordingly, the engine power is not affected when the water/methanol system is used.

6.5 Engine Starting

To prevent hot start under strong wind condition, starting with tail wind should be avoided and engine should be started with head wind as far as practicable.

Check controls, switches, indicators, and warning lights, in accordance with the check list. Especially important items are as follows:

whether proper power supply is being engaged;
whether the throttle lever is in FULL CLOSE position;
whether the fuel trimmer is 0%; and
whether the propellers are at the ground fine pitch.

6.5.1 Engine Starting

The engine shall be started in accordance with the check list.

(1) The starter button must not be pressed down while the propeller is rotating. Accordingly if the starter is disengaged during start, the button must not be pressed again before the propeller rotation stops.

(2) The starter must not be disengaged before the engine has started perfectly up to at least 3,500 r.p.m. without excessive T.G.T. However, since the starter is automatically disengaged after 30 seconds, set the starter switch to "SAFE" to stop the starter motor if the starter is not disengaged even after 30 seconds.

(3) In order to prevent hot start, the throttle lever must not be moved to IDLE position during engine starting.

(4) During engine starting operation, the relight switch must be in OFF position.

With a normal start, the r.p.m. will rise soon after pressing the starter button and, after lighting up, the T.G.T. will rise and the engine will accelerate to steady idling. Then the T.G.T. will come down within the idling limitation.

Starting is permitted at temperature as low as -30°C when external power source is used, or -10°C when internal batteries are used. The maximum permitted T.G.T. is 930°C. If T.G.T. approaches this limit at extreme low ambient air temperature, the start is not regarded normal. The normal maximum starting T.G.T. should be 700 to 800°C and if it is obvious that these temperatures will be exceeded under normal conditions, the start should be cancelled. The cause for high T.G.T. at the time of engine start is the insufficient starting voltage. The power source, therefore, should be checked.

NOTE: For starts at oil temperatures between 0°C and -10°C on internal batteries, which have been preceded by a wet crank (motoring for less than 30 seconds with the H.P.C. in "FUEL ON" position and the starter selector switch in "BLOW OUT" position), a T.G.T. limit of 930°C is permitted. The use of 930°C is strictly limited to this condition.

6.5.2 Failure to Start

If the T.G.T. does not rise and the engine fails to light within 20 seconds after starting, or if the engine speed fails to rise above motoring speed (2,100 r.p.m. max.) within a maximum of 30 seconds after the engine has been lit, the engine must be stopped immediately with the following settings.

H.P. fuel cock	FUEL OFF
Starter master switch	SAFE

A further attempt to start must not be made until the propellers have stopped rotating. If there has been any delay in closing the H.P. cock, carry out a motoring cycle (BLOW OUT). This should be done in any case after two failures of starting.
To motor the engines over, the normal starting procedures must be followed except:

H.P. fuel cock	FUEL OFF
Starter master switch	BLOW OUT

When carrying out a motoring cycle, the 30 seconds limitation of the starter motor operation must be observed. Therefore, after 30 seconds stop the motor by setting starter switch in "SAFE".
After performing starting or blow-out operations six times in all, the starter motor must be put at rest for at least 15 minutes for cooling. When the intermal batteries are used for starting the engines, unnecessary systems must not be operated as much as practicable in order to prevent waste of power.
After starting one engine, the generator is used. For this purpose, set the engine speed to 7,500 r.p.m. Higher or lower speed than 7,500 r.p.m. is inadequate for the engine.
The other engine shall be started after generator power has become less than 200A.

6.6 Ground Run

6.6.1 Ground Run

CAUTION: THE GUST LOCK CONTROL LEVER MUST BE ON DURING GROUND RUNNING OF EITHER OF THE ENGINES TO RETAIN THE FLIGHT FINE PITCH STOP SELECTOR LEVER IN GROUND POSITION. THEN, THE PROPELLER SPEED GOES DOWN, WITHOUT STOPPING AT LOW STOP AND ENGINE BURNING, WHEN THE SPEED IS REDUCED, AND THE STOP AT 12° IS OFF.

If the engine power is suddenly retarded from high-speed when the airplane is stationary on the ground, a tremendous stress is likely to be applied to the propeller blades. Accordingly when moving the throttle lever from high-speed, do so gently; especially between 15,000 r.p.m. and 14,000 r.p.m.,

H.P. fuel cock FUEL OFF
Starter master switch SAFE

A further attempt to start must not be made until the propellers have stopped rotating. If there has been any delay in closing the H.P. cock, carry out a motoring cycle (BLOW OUT). This should be done in any case after two failures of starting.
To motor the engines over, the normal starting procedures must be followed except:

H.P. fuel cock FUEL OFF
Starter master switch BLOW OUT

In case of motoring, the starter motor is also cut off automatically in 30 sec. Therefore, if it is not cut off in 30 sec., stop the starter by setting the starter switch to "SAFE."
After performing starting or blow-out operations six times in all, the starter motor must be put at rest for at least 15 minutes for cooling.
When the internal batteries are used for starting the engines, unnecessary systems must not be operated as much as practicable in order to prevent waste of power. After starting one engine, the generator is used. For this purpose, charge the battery by means of the generator. Before the other engine is started, set the engine speed at 7,500 rpm.
The other engine shall be started after generator power has become less than 200A.

6.6 Ground Run

6.6.1 Ground Run

CAUTION: THE GUST LOCK CONTROL LEVER MUST BE ON DURING GROUND RUNNING OF EITHER OF THE ENGINES TO RETAIN THE FLIGHT FINE PITCH STOP SELECTOR LEVER IN GROUND POSITION. THEN, THE PROPELLER SPEED GOES DOWN, WITHOUT STOPPING AT LOW STOP AND ENGINE BURNING, WHEN THE SPEED IS REDUCED, AND THE STOP AT 12° IS OFF.

If the engine power is suddenly retarded from high-speed when the airplane is stationary on the ground, a tremendous stress is likely to be applied to the propeller blades. Accordingly when moving the throttle lever from high-speed, do so gently; especially between 15,000 r.p.m. and 14,000 r.p.m., there must be at least 5 seconds before throttling is completed.
When the engines are run with the airplane stationary on the ground, the airplane must be directed to the wind and cross wind in excess of 30° should be avoided.
Also, continuous operation at less than 7,000 r.p.m. and at any speed between 12,000 r.p.m. and 14,000 r.p.m. shall be avoided.

6.6.2. Taxiing

Taxiing should always be carried out with the gust lock control lever ON to ensure that the flight fine pitch stop selector lever is in GROUND position. Do avoid engine run for a long time at speeds between 12,000 r.p.m. and 14,000 r.p.m.
When moving the throttles, do so gently to avoid high T.G.T.
Below flight fine pitch stop lights may flicker on and off during taxiing.

PREVAILING AIR TEMPERATURE - degree °C	-1000	-500	- 250	0	500	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
+ 45	.765	.752	.746	.740	.726	.713	.685	.655	.629	.608					
+ 40	.805	.792	.783	.776	.764	.751	.720	.692	.666	.642	.611				
+ 35	.845	.831	.824	.816	.802	.790	.758	.731	.704	.679	.648	.625			
+ 30	.887	.873	.865	.858	.842	.829	.796	.770	.741	.715	.684	.660	.632		
+ 25	.933	.916	.908	.902	.885	.871	.837	.810	.782	.752	.720	.695	.666	.642	.615
+ 20	.981	.965	.955	.948	.931	.913	.880	.850	.823	.791	.760	.731	.702	.676	.648
+ 15	1.015	1.008	1.004	1.000	.981	.960	.925	.893	.863	.830	.798	.768	.737	.710	.682
+ 10	1.008	1.001	1.000	.995	.988	.980	.965	.938	.905	.870	.837	.806	.775	.745	.716
+ 5	1.002	.995	.992	.988	.981	.975	.960	.945	.930	.912	.880	.845	.814	.784	.751
0	.993	.988	.985	.980	.975	.968	.955	.941	.926	.910	.895	.880	.855	.823	.790
- 5	.985	.979	.975	.971	.966	.960	.946	.933	.920	.905	.892	.877	.862	.846	.830
- 10	.975	.970	.966	.963	.958	.952	.938	.925	.912	.898	.885	.871	.856	.840	.825
- 15	.965	.959	.955	.952	.946	.942	.929	.915	.894	.888	.875	.863	.849	.832	.819
- 20	.955	.948	.945	.941	.937	.930	.918	.905	.892	.879	.863	.850	.838	.820	.808
- 25	.942	.937	.934	.930	.924	.920	.905	.892	.880	.867	.852	.835	.822	.805	.792
- 30	.929	.923	.920	.916	.912	.905	.894	.878	.866	.855	.837	.819	.805	.788	.775
- 35	.916	.912	.906	.904	.895	.891	.879	.862	.850	.839	.821	.800	.785	.770	.754
- 40	.905	.898	.894	.888	.883	.877	.866	.846	.835	.825	.806	.784	.768	.751	.729

Fig. 6-8 PRESSURE ALTITUDE

Corrections to power check pressure

T.G.T. MAX. 840
E.P.C.P. ORIGINAL 333 psi
W.M.C.P. 381 psi

	-1000	-500	-250	0	500	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
+ 45	255	251	248	246	242	238	228	218	210	202					
+ 40	268	264	261	258	254	250	240	230	222	214	204				
+ 35	281	277	274	272	267	263	252	243	234	226	216	208			
+ 30	295	291	288	286	280	276	265	256	247	238	228	220	210		
+ 25	311	305	302	300	295	290	279	270	260	250	240	231	222	214	205
+ 20	327	321	318	316	310	304	293	283	274	263	253	243	234	225	216
+ 15	338	336	334	333	327	320	308	297	287	276	266	256	245	236	227
+ 10	336	333	333	331	329	326	321	312	301	290	279	268	258	248	238
+ 5	334	331	330	329	327	325	320	315	310	304	293	281	271	261	250
0	331	329	328	326	325	322	318	313	308	303	298	293	285	274	263
- 5	328	326	325	323	322	320	315	311	306	301	297	292	288	281	276
- 10	325	323	322	321	319	317	312	308	304	299	295	290	285	280	275
- 15	321	319	318	317	315	314	309	305	298	296	291	287	283	277	273
- 20	318	316	315	313	312	310	306	301	297	293	287	283	279	273	269
- 25	314	312	311	310	308	306	301	297	293	289	284	278	274	268	264
- 30	309	307	306	305	304	301	298	292	288	285	279	273	268	262	258
- 35	305	304	302	301	298	297	293	287	283	279	273	266	261	256	251
- 40	301	299	298	296	294	292	288	282	278	275	268	261	256	250	243

Fig. 6-9 PRESSURE ALTITUDE- ft.

ENGINE SERIAL NO. 21005

The T.G.T. limitation at the time of take-off is 865°C. However, the maximum T.G.T. differs within this limitation with each engine. If the ambient air temperature is below ISA, the T.G.T. indication is low. Therefore, T.G.T. correction becomes of necessity to the ambient air temperature when the power check is accomplished. Fig. 6-10 shows the T.G.T. correction.

6.7.2 After Take-off

If water/methanol has been used for take-off, the following check should be carried out at an altitude not less than 400 feet above the airfield.

Throttle lever	Set to CLIMB POWER
Water/methanol master switch	OFF
Water/methanol booster pump switch	OFF (pressure indicator light OUT)
H.P. fuel cock	FUEL ON

When the throttle lever is placed in CLIMB POWER (14,200 r.p.m.), the water/methanol injection stops automatically before the water/methanol switch is turned off.

6.7.3 Climb and Cruise

When the normal climbing speed has been reached, power is reduced to a value required for the en route climb to the operating altitude (14,200 r.p.m.; 770°C) and fuel heaters are set to AUTO as required.
Fuel trimmer shall be operated, during climb and cruise, to ensure that the T.G.T. limits are not exceeded. The positions of both fuel trimmers in flight are not related except when they are directly related in case of low torque pressure or fuel flow.
When the true airspeed exceeds 187 kts T.A.S. at cruise power, make sure that the high stop remove light and the high stop unsafe light go out.

6.7.4 Descent

During normal descent, the engine torque pressure is about 100 psi.
A higher or lower power may be used for descent depending upon the circumstances; however, for a descent at a lower power, the engine torque pressure must not be less than 40 psi.

6.7.5 Approach and Landing

Obtain the prevailing temperature and pressure altitude informations at the destination airfield from the control tower, to set the fuel trimmer to day trim. This is important to obtain appropriate power in the event of go-around.
Accomplish check for approach and landing in accordance with the check list.

CAUTION: NOTE THAT, AFTER A LONG-TIME FLIGHT BELOW -20°C, WATER/METHANOL INJECTION, IN SOME CASES, CAN NOT BE UTILIZED IN THE EVENT OF GO-AROUND.

6.7.6 After Landing

After touching the ground, place the low stop lever in GROUND position as early as possible. Confirm by means of the lighting of the low stop unsafe lights and the below low stop lights that the propellers have been decreased to the ground fine pitch.

Prior to opening throttles for taxiing, engage the gust lock so that the low stop lever will not move from GROUND.

When stopping the engines, place the H.P. cock in FUEL OFF after fully closing the throttles.

If the use of the propeller brakes is required, apply the brakes after the engine speeds have dropped below 3,000 r.p.m.

6.8 De-icing

.8.1 Engine De-icing

The de-icer must be switched on at all times when the indicated air temperature is below +10°C unless it is certain that icing condition will not be encountered.
It is important that the correct cycling is selected according to the outside air temperature.

6.8.1.1 Take-off

For take-off in icing or in conditions of high humidity with visible moisture at air temperatures below +5°C, check:

Engine de-ice master switch	ON
Fast-Slow cycling switch	FAST or SLOW (SLOW below -15°C true or -10°C indicated air temperature)
Red and amber lights	OUT

6.8.1.2 All Flight Conditions

Except when it is certain that icing condition will not be encountered, check as stated under "Take-off".

6.8.1.3 Delayed Use

If, for any reason, icing condition is encountered before the selection of the de-icing system, proceed as follows.

Relight switches of both engines	ON (Check indication light)
No. 1 engine de-ice master switch	ON
FAST-SLOW cycling switch	SLOW or FAST (To be selected following the procedures for Take-off)
Red or amber light	Check "OUT"
After one minute:-	
No. 2 engine de-ice master switch	ON
Red or amber light	Check "OUT"
After two minutes:-	
Relight switches of both engines	OFF

This is for the purpose of preventing the occurrence of flame-out probably arising due to ingress of melting ice into the engines.

NOTE: 1. If descending into conditions where the indicated air temperature is above -5°C, it is advisable to discontinue the descent until the above steps have been completed.

2. In the event of low power conditions, it is advisable to continue flight for about 5 seconds at 14,200 r.p.m. after the completion of the above steps, and then see if the power of each engine is adequate.

Except in an emergency, no attempt to restart the engines should be made after flight through icing exceeding 5 minutes. If the emergency is urgent, it is advisable to fly as long as practicable at an indicated air temperature of+5°C or higher prior to attempting to restart.

If flame-out has occurred, feather the propeller and carry out restarting immediately. However, if it is necessary to effect a rapid relight, this can be achieved by throttling back, switching on the relight switch, and then re-opening the throttle to obtain the required power. Finally, switch off the relight switch when the de-icing system is normal. If, however, automatic feathering has taken place, normal relight procedure will be necessary.

6.8.2 Fuel Filter De-ice

6.8.2.1 During Taxiing

If the fuel heater warning light comes on during taxiing, at the indicated outside air temperature of +5°C or below switch the fuel heater ON and leave it on for two minutes prior to take-off. If warning light is still ON after the above procedure, or warning light comes on at outside air temperature at which icing can not be expected, flight must be discontinued.

6.8.2.2 Take-off

If the fuel filter de-icing warning light comes on during take-off before V_1 is reached, abort the take-off. If the light comes on after V_1 has been reached, no particular procedures are taken until the airplane takes off safely. Then, turn on both fuel de-icing switches and keep them on for two minutes after the warning light went out. Subsequently, set the fuel de-icing switches to "AUTO."

6.8.2.3 Climb and Cruise

Set the fuel filter de-icing switch to "AUTO." Then, de-icing is accomplished automatically whenever the warning light comes on.

In case that the fuel filter de-ice warning light is on for more than two minutes, set the fuel de-icing switch to "MANUAL" for two minutes. Then, set the switch to "AUTO." If the warning light does not go out for all that, set the fuel de-icing switch to "MANUAL" and leave it there.

If the above procedures are not accomplished in time, set the relight switch of one engine to "ON" and set the fuel de-icing switch to "MANUAL" for 2 minutes at least. Then, turn on the relight switch of the other engine and set its fuel de-icing switch to "MANUAL."

If both engines are functioning normally, turn off both relight switches.

If the engine speed or T.G.T. begins to fluctuate, retard the throttle lever to "MIN."

If the engine speed and power keep dropping for all that, feather the propeller manually and try to relight the engine as soon as possible.

6.8.2.4 Descent

When the throttle is retarded for descent, set the fuel de-icing switch to "AUTO."

6.8.2.5 Approach and Landing

Keep the fuel de-icing switch in "MANUAL" for 2 min. within 5 min. before landing and turn it off later. This is not necessary if the indicated outside air temperature is above +5°C throughout the entire flight.

NOTES: 1. If the fuel de-icing switch is turned on, the torque pressure and T.G.T. vary a little.
If the trimmer range permits, readjust the trimmer to maintain the desired T.G.T.

2. In case the efficiency of the fuel de-icer is not enough, it can be improved by setting the fuel trimmer to "Full Decrease" and opening or closing the throttle lever.

3. If the warning light is on for a long time, the fuel low pressure warning light may come on. In addition, if the fuel pressure drops, combustion may be interrupted.

6.9 Auto-feather

If a propeller has auto-feathered, perform the steps of manual feather as early as practicable after auto-feather except at the time of take-off, so that the feathering pump electric circuit will be interrupted and protected from burning. At the time of take-off, carry out the manual feathering operation, after completion of take-off, as time permits. A care shall be exercised so that the feather pump will not be used for over 3 continuous minutes.

6.9.1 Relighting after Auto-feathering

If a propeller has auto-feathered due to loss of low pressure fuel caused by either booster pump failure, electrical failure affecting the booster pumps, or erratic operation of the airplane fuel system, then relight may be carried out when low pressure fuel system has been restored to the normal conditions.

6.10 Manual Feather

6.10.1 Manual Feathering Procedures

H.P. cock	Feather (by this, fuel and W/M are shut off.)
Feathering switch	To be kept depressed until feathering has been completed.
Throttle	FULL CLOSE
Prop. sync. switch	OFF (when in use)
W/M master switch	OFF (when in use)

NOTE: 1. If time permits or in training, it is advisable to stop the propeller synchronizer switch first.

2. After feathering, the high stop unsafe light comes on.

6.10.2 Emergency Feathering

Should a propeller fail to feather after the H.P. cock is placed in FEATHER position and the feathering pump switch is depressed, the automatic feathering system must be operated as follows.

(1) Close L.P. fuel shut-off valve (Emergency fuel shut-off valve).

(2) Open throttles fully.

(3) Place H.P. cock in FUEL ON or LOCK OUT.

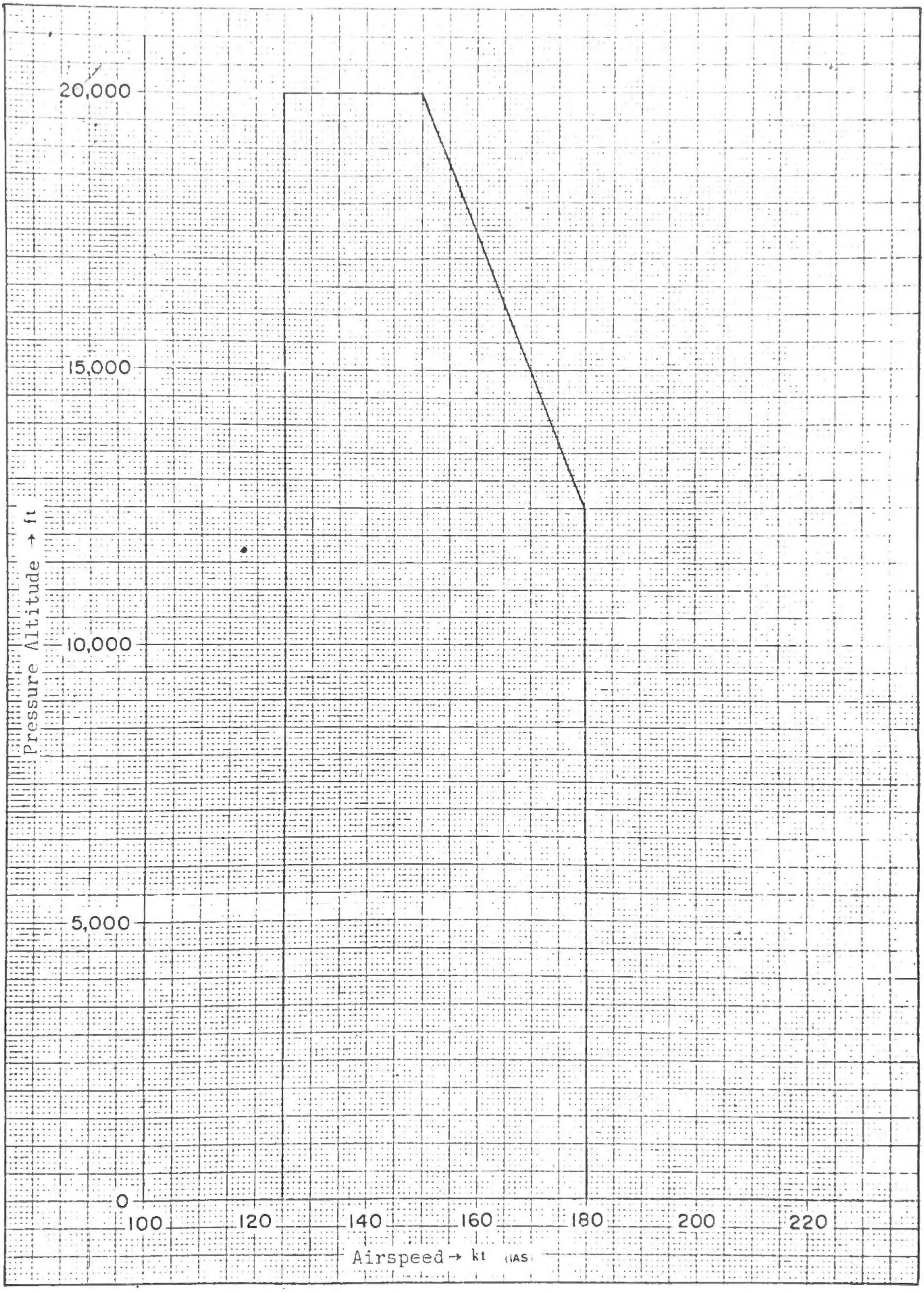
(4) When feathering has been completed, open the feathering pump circuit breaker for the engine concerned.

The action as in (4) will isolate the feathering motor, so preventing it from burning, while retaining electrical feathering selection through the automatic solenoid.

6.11 Restarting in Flight

6.11.1 Relighting Procedures in Flight

IAS	Within the range given in Fig. 6-11.
Throttle	FULL CLOSE
L.P. fuel shut-off valve	OPEN
Fuel trimmer	Same as other engine
Fuel booster pumps	ON
Relight switch	ON
Ignition light	Check ON
H.P. cock	FUEL ON
Feathering switch	To be kept depressed till engine speed begins to rise.
T.G.T.	Check rise. In this case, it may be necessary to open throttles slightly to confirm the rise of T.G.T. If no relight, within 30 seconds, feather again and repeat the same steps after fuel draining during flight for two minutes.
Oil	Check temperature and pressure.
Throttle	Open slowly; and with both throttles levelled, check torque pressure to confirm completion of relight. (If relight has been successful, follow the steps shown in 6.11.2.)
Fuel trimmer	Trim as required
Relight switch	OFF
Ignition light	OUT
	Do not use relight switch for ten minutes continuously.



Limitation Envelope for Relight in Flight

Fig. 6-11

6.11.2 Confirmation of Satisfactory Relight

If it is evident that the relight is successful only partially, close and open the throttles rapidly two or three times to approximately the half open position, avoiding the initiation of the auto-feathering system, and recheck torque pressures; the feathering pump warning light may flicker on and off during this operation. Avoid excessive T.G.T. If a complete relight has not been obtained, feather it again.
Before relighting is tried again after failing relighting and feathering propeller again, continue flight for 2 minutes at least with propeller feathers, draining residual fuel in combustion chamber. Relighting should not be tried more than once successively unless in case of emergency.
If relighting is done at true airspeeds less than 175 knots, when the high stop remove light remains out, it means that this stop has failed to withdraw. Accordingly do not open the throttles before the H.P. cock is placed in LOCK OUT.
The propellers should not be unfeathered unless the oil temperature is within the limitation.

6.12 Engine Failure during Take-off

6.12.1 When Take-off Is Continued

No special action is required since the propeller feathers automatically. After take-off, carry out the manual feathering steps on the failed engine. If water/methanol is used for take-off, increase the fuel trimmer position on the live engine by 15%, if possible. Subsequently set to maximum continuous T.G.T. limit of 890°C.

CAUTION: THE FUEL TRIMMING ON THE LIVE ENGINE MAY RESULT IN OVERSHOOTING THE T.G.T. LIMIT OF 890°C. THE T.G.T. MUST NOT, HOWEVER, BE ALLOWED TO EXCEED THE 950°C FOR 5 SECONDS LIMITATION DESCRIBED EARLIER.
THE ABOVE PROCEDURE MUST BE USED ONLY IN THE EVENT OF ENGINE FAILURE DURING TAKE-OFF OR SINGLE ENGINE GO AROUND.

6.12.2 When Take-off Is Abandoned

Immediate actions to be taken:

Throttles	FULL CLOSE
Low stop lever	GROUND

To utilize propeller drag effectively, do not feather.

6.13.5 When High Stop Fails to Withdraw

If the high stop does not withdraw (high stop remove light will not come on) even when the airspeed is substantially reduced below 187 kts, or if the number of revolutions decreases excessively, the high stop should be withdrawn manually with the H.P. cock set to "LOCK OUT" position.
Should the true airspeed then be increased above 187 kts, the H.P. cock must be returned to "FUEL ON" to engage the high stop again.

6.14 Engine Fire

6.14.1 Fire in Flight

H.P. cock	Feather (This also turns off fuel and water/ methanol.)
Feathering switch	To be kept depressed until feathering is completed.
Emergency fuel shut-off valve	During feathering or immediately after placing H.P. cock in FEATHER, close the valve as early as possible. (Pull) This turns off low pressure fuel and hydraulic oil, the fire extinguisher circuit being completed.

When feathering has been completed:

Fire extinguisher switch	1st shot
Throttle lever	Fully closed if time permits.

If the fire warning light remains of after 30 seconds:

Fire extinguisher switch	2nd shot

NOTE: The engine must not be restarted after the fire warning light has come on. Also, the emergency fuel shut-off valve should not be opened.

6.14.2 Engine Fire During Ground Run

H.P. cock	Feather

If engine is being started:

Starter master switch	Safe
Feather switch	To be kept depressed until feathering is completed.
Emergency fuel shut-off valve	Close, by the same procedure as "In Flight."

After completion of feathering operation, utilize the ground fire extinguisher equipment if fire fighting crew are present on the ground. If fire still persists,

Fire extinguisher switch	1st shot As the fire extinguishing agent is noxious, a full care shall be taken to keep it away from persons on the ground.

If the other engine is running, the propeller of that engine must also be feathered to facilitate ground fire fighting.

NOTE: An engine must not be restarted after the fire warning light came on. Also the emergency fuel shut-off valve must not be opened.

6.15 Engine Overheat

6.15.1 Operation

Engine overheat will be indicated by the overheat warning light.

H.P. cock	Feather
Feather switch	To be kept depressed until completion of feathering.
Emergency fuel shut-off valve	Pull to close the valve.

Pay attention to the fire warning light.

NOTE: The fire extinguisher should not be used only because engine overheat warning has come on.
The engine should not be restarted after its overheat warning light came on. Also, the emergency fuel shut-off valve should not be opened.

6.16 Failures of Mechanism and System

6.16.1 On the Ground

Symptom	Remedy
Idling r.p.m. inadequate.	Quickly open throttle about 1 in. and then close.

6.16.2 In Flight

Symptom	Remedy
Sudden drop of T.G.T., or sustained vibrations (exclud. momentary vibrations)	Feather
Oil pressure 1. Vibrations 2. Too high (accompanying phenomena: r.p.m. decrease, torque decrease, and T.G.T. rise) 3. Decrease	1. Attend to oil temperature gauge. 2. Feather 3. Feather
Torque pressure 1. Vibrations 2. Sudden decrease	1. Lower power to torque pressure 40 ~ 50 psi. Restore initial power after vibrations are gone. If vibrations persist, feather. 2. Feather

Chapter 6 HYDRAULIC SYSTEM

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Chapter 6 HYDRAULIC SYSTEM

6.1 General

The hydraulic system employed in the YS-11 is of closed center type and consists of main and auxiliary systems.

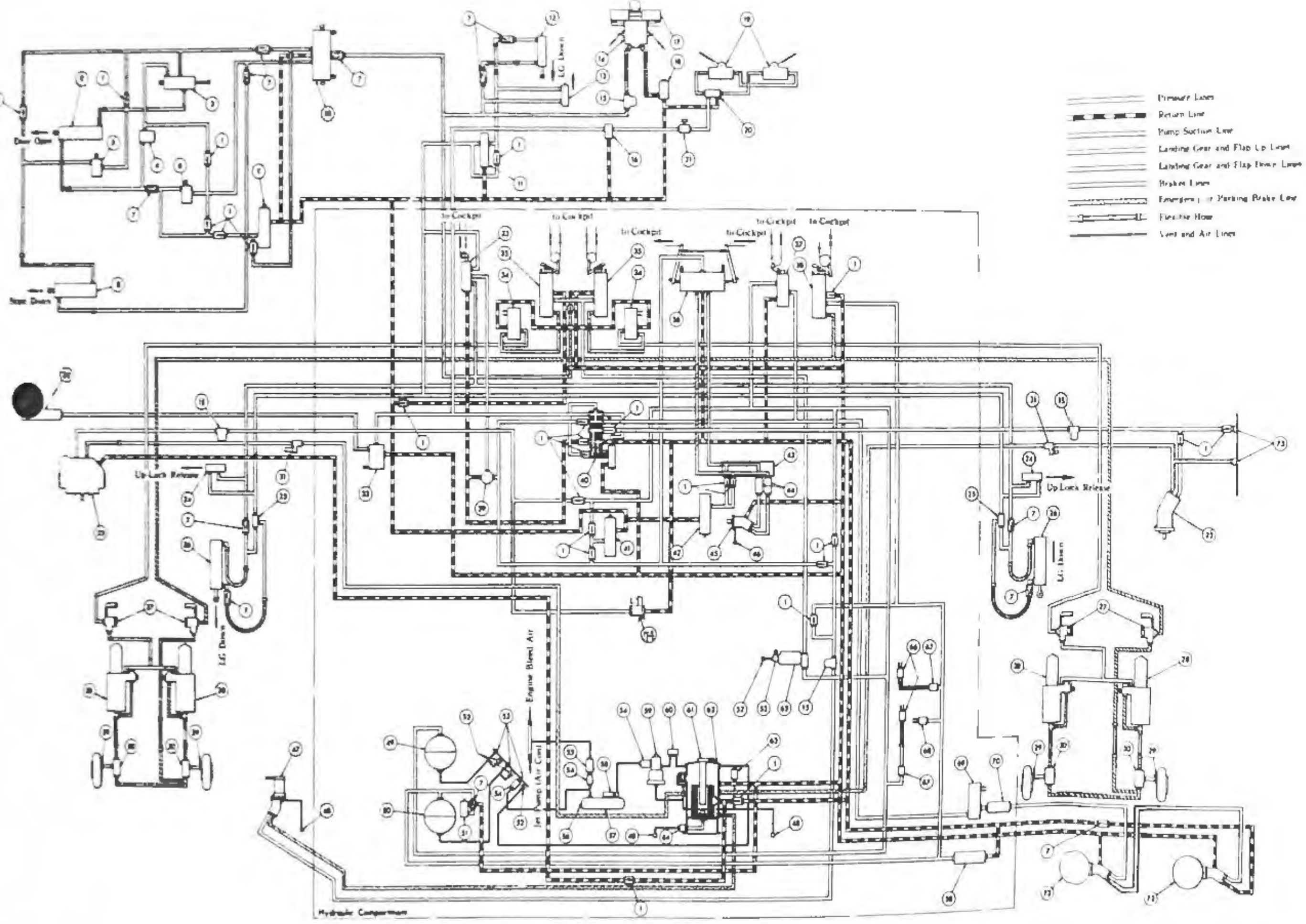
The pressure source consists of two engine driven pumps and one motor driven pump, its system pressure being 3,000 psi. The hydraulic fluid shall conform to MIL-H-5606A. The full capacity of the system is 50 liters.

Pressure supply system consists of the following nine systems:

	System	System pressure (psi)	Remarks
Non-Essential	Windshield Wiper	2000	
	Ground Cooling Fan	Approx.1500(Max)	2ea Series
	Propeller Brake	3000	
Essential	Landing Gear	3000 (Nose Up 2000)	See ch. 3
	Steering	3000	"
	Flap	2000	See ch. 7
	Stair Way	3000(Up) 1200(Dn)	
Brake	Normal & Parking Brake	1200	See ch. 3
	Emergency Brake	2300	"

The control valves for all the operating systems are arranged in the hydraulic compartment. The indicators, warning lights, control switches and control levers of the hydraulic system are arranged in the copilot flight instrument panel.

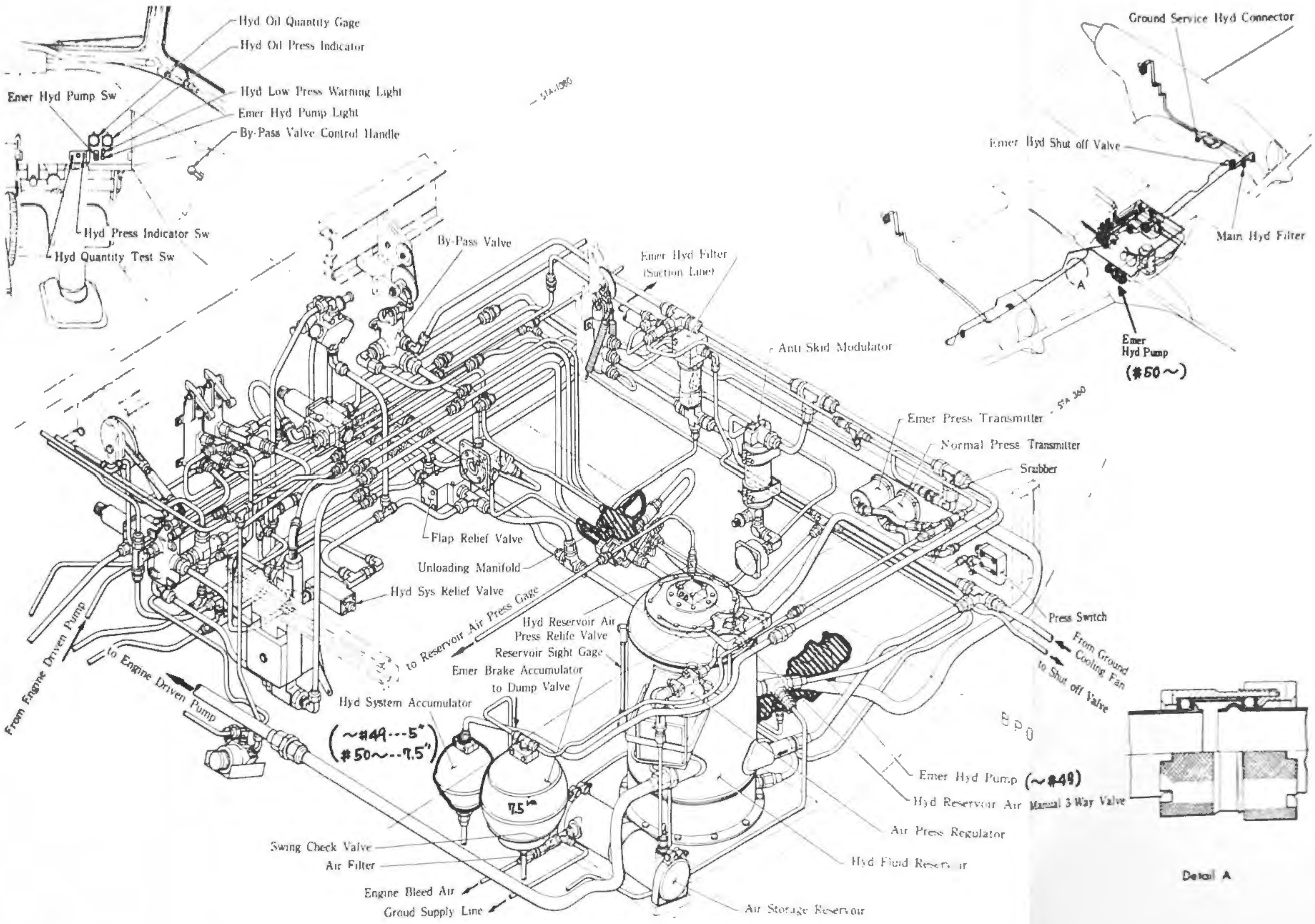
The ground test stand connection is located in the starboard nacelle. It is used in place of the starboard engine driven pump.



Hydraulic System Schematic Diagram

Figure 6-2

1) Check valve
2) Door actuating cylinder
3) Door lock cylinder
4) Door close sequence valve
5) Door open sequence valve
6) Stair sequence valve
7) Restrictor
8) Stairway actuating cylinder
9) Door relief valve
10) Stairway control valve
11) Reducing relief valve
12) N.L.G. actuating cylinder
13) N.L.G. up-lock cylinder
14) Nose wheel steering control valve
15) Filter
16) Wiper reducing relief valve
17) Nose wheel steering actuating cylinder
18) Back pressure valve
19) Wiper window unit
20) Wiper control unit
21) Wiper speed control valve
22) Propeller brake
23) Engine driven pump-variable delivery
23') Engine driven pump-constant delivery
24) M.L.G up-lock cylinder
25) M.L.G by-pass valve
26) M.L.G actuating cylinder
27) Swivel joint
28) Brake lock-out cylinder
29) Bleeder valve
30) Shuttle valve
31) Emergency shut-off valve
32) Propeller brake control valve
33) Landing gear control valve
34) Anti-skid control valve
35) Power brake valve
36) Flap control valve
37) By-pass valve
38) Emergency brake valve
39) Emergency landing gear release valve
40) Unloading manifold
41) System relief valve
42) Flap relief valve
43) Manifold
44) Flow regulator
45) Flap torque motor
46) Seal drain
47) Emergency hydro pump
48) Exterior drain
49) System accumulator
50) Emergency accumulator
51) Controllable check valve
52) Pressure guage
53) Air charging inlet
54) Swing check valve
55) Air filter
56) Drain plug
57) Air storage reservoir
58) Relief valve
59) Pressure regulator
60) Reservoir change 3-way cock
61) Fluid quantity transmitter
62) Reservoir
63) Reservoir relief valve
64) Drain valve
65) Anti-skid pressure modulator
66) Pressure transmitter
67) Snubber
68) Pressure switch
69) Ground cooling fan shut-off v
70) Priority valve
71) Pressure reducing relief valv
72) Ground cooling fan
73) Test stand connectors
74) Shut-off valve



Hydraulic Power System

Figure 6-3

6.2 Hydraulic Pressure Source System

6.2.1 Main System

(1) General

This system consists of a hydraulic pressure source system with two engine driven hydraulic pumps, a return oil system from all operating systems, a reservoir and its pressurizing system.

Hydraulic fluid is fed to the engine driven hydraulic pumps mounted on the front of both starboard and port engine gear boxes from the reservoir of the hydraulic compartment by a 1"ø pipe. In the intermediate part (WS. 2000 on the back side of the wing rear spar) of the pipe, an emergency shut off valve is located to shut off oil supply to the pumps in the event of an engine fire.

Pressures of hydraulic oil, regulated at 3000±100 psi in case of the L.H. side variable pump and 2600 to 3100 psi regulated by the unloading valve in case of the R.H. side constant pump are fed to the control valves of eight hydraulically operated systems (except for the emergency brake). When no hydraulic pressure is used during flight, the pump load can be reduced by using the by-pass valve which keeps the unloading valve at rest.

Hydraulic oil used in each system goes back to the reservoir through the following two independent return lines:

(A) System return line,

(B) Brake return line.

The purpose of making these lines independent of each other is to prevent the surge pressure of the system return line from affecting the brakes. While the system return oil goes through the check valve to the filter in the reservoir, the brake return oil passes through neither the check valve nor the filter in the reservoir to facilitate return from the brakes.

(2) Operation Check (System Internal Leak Check)

Connect the hydraulic test stand and ground power unit to the aircraft and set the by-pass lever to NORMAL.

(A) Set the pressure of the hydraulic test stand to 3,000 psi and the flow rate to 10 GPM.

(B) The cut-out and cut-in time shall be more than one minute and 20 seconds.

(C) After another cut-out, set the by-pass lever to By-Pass and stop the hydraulic test stand. At this point, check that the hydraulic pressure gage of the aircraft indicates more than 3,000 psi.

(b) The time required for the hydraulic pressure gage of the aircraft to drop to 2,000 psi shall be more than 30 minutes.

6.2.2 Hydraulic Reservoir

Specifications

Full capacity:	29.0ℓ
Full oil capacity:	23.5ℓ
Normal oil capacity:	15.7ℓ
Emergency oil capacity:	7.8ℓ
Expansion space:	5.5ℓ
Proof pressure:	50 psi

The hydraulic reservoir is located in the hydraulic compartment and is common to the main and auxiliary systems.

The emergency side suction port is lower than the main side so that even if the hydraulic oil of the main system runs short, 7.8 liters of hydraulic oil can be used by the emergency pump.

The position of the reservoir is lower than that of the engine driven hydraulic pump so that engine bleed air is used for its pressurization.

Brake return with low flow rate goes directly into the center of the reservoir, while system return goes from the return chamber through the filter into the center of the suction chamber. If the filter is blocked, the relief valve mounted on the return chamber is actuated, permitting oil return to the suction chamber without passing through the filter. The opening pressure of the relief valve is 6±0.5 psi, while the closing pressure is 5.3±0.5 psi.

In the center of the reservoir, an oil quantity gage transmitter is suspended from the ceiling. The sight gages have Full and Refill marks to indicate how much oil is contained in both accumulators.

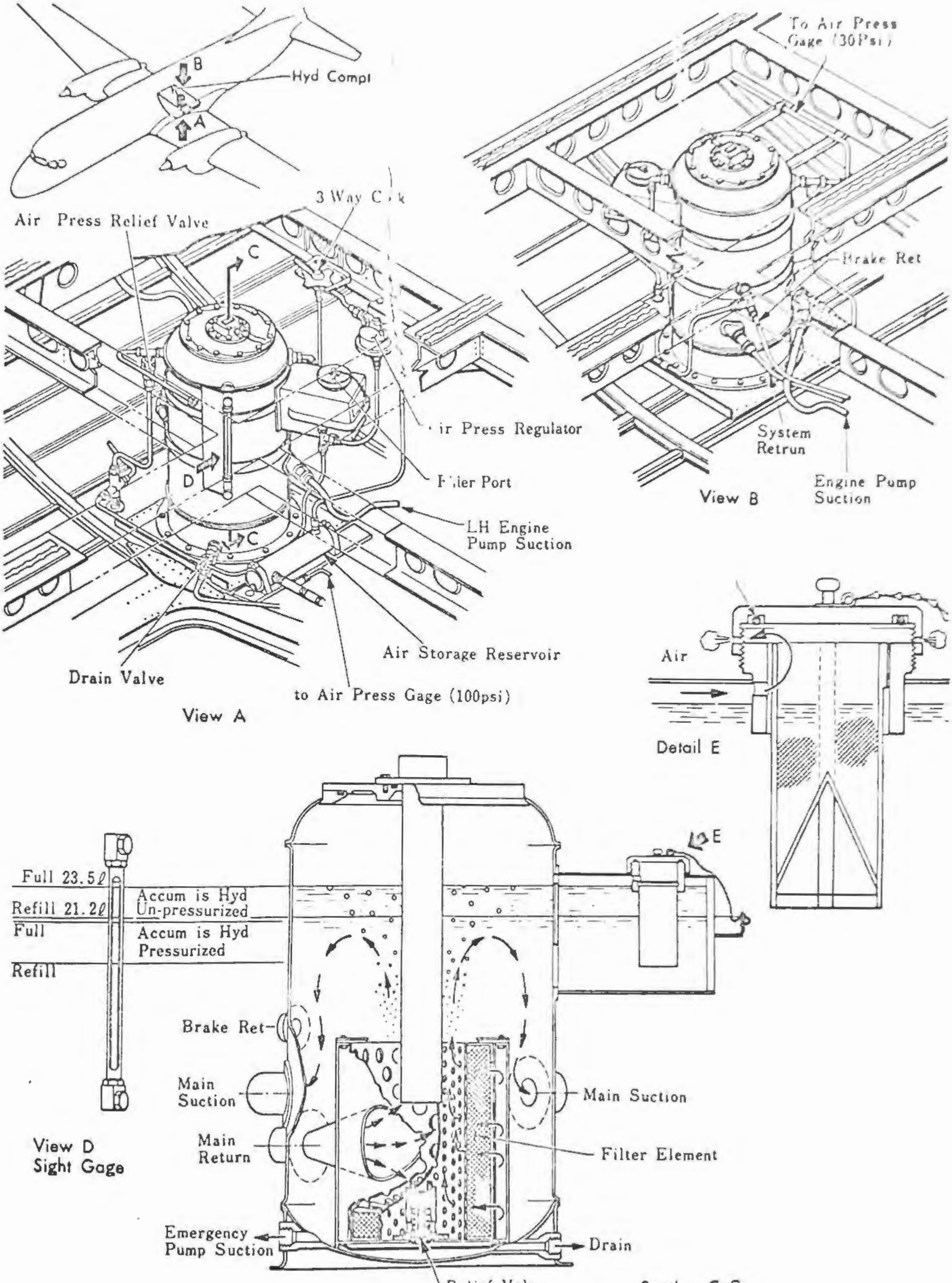
6.2.3 Hydraulic Reservoir Pressurization System (Fig. 6-2)

Bleed air from the 2nd stages of both engine compressors goes through the air filter and swing check valve to the air storage reservoir (located just below the hydraulic reservoir).

This reservoir accumulates 2.1 liters of bleed air and serves as the air pressure source of the hydraulic reservoir.

Air from the air storage reservoir goes into the air pressure regulator. Between these, a relief valve is located which holds down the pressure of the air storage reservoir to less than 100 psi.

The air pressure is regulated to 25 to 30 psi by the air pressure regulator and goes through the manual 3-way valve to the upper part of the hydraulic reservoir. With the manual 3-way valve in normal position, air goes from the regulator into the reservoir. To open the hydraulic reservoir, place the valve in closed position, and the air in the air storage



Hydraulic Reservoir

Figure 6-4

reservoir is stored, while the air in the hydraulic reservoir is expelled.

At the front right of the hydraulic reservoir, a relief valve is located which relieves the internal pressure of the reservoir when it becomes more than 22 psi higher than the internal pressure of the aircraft.

6.2.4 Engine Driven Hydraulic Pump

(1) General

The L.H. side pump is of variable delivery type and the R.H. side pump is of positive displacement type, both being vickers products.

The delivery rates of the pumps are 8.19 GPM (Max. 8.65 GPM) at cruising in case of the variable delivery type (L.H. side) and 7.80 GPM (Max. 8.25 GPM) at cruising in case of the positive displacement type. The delivery pressure of the pump of the former type is automatically regulated but the pressure of the pump of the latter type is not. Therefore, it requires an unloading valve for the pressure regulation.

(2) Operation Check

(A) Start one engine by normal procedures and set the engine speed to 7,500 rpm.

(B) Set the by-pass lever to Normal.

(C) Check that the hydraulic pressure gage of the aircraft indicates 2,600 to 3,100 psi.

(D) Set the ground cooling fan switch to "ON". Then, check that the hydraulic pressure gage indicates 1,900 to 2,100 psi.

(E) Set the ground cooling fan switch to "OFF".

(F) Start and set the speed of the other engine to 7,500 rpm.

(G) Set the ground cooling fan switch to "ON". Then, check that the hydraulic pressure gage indicates to psi.

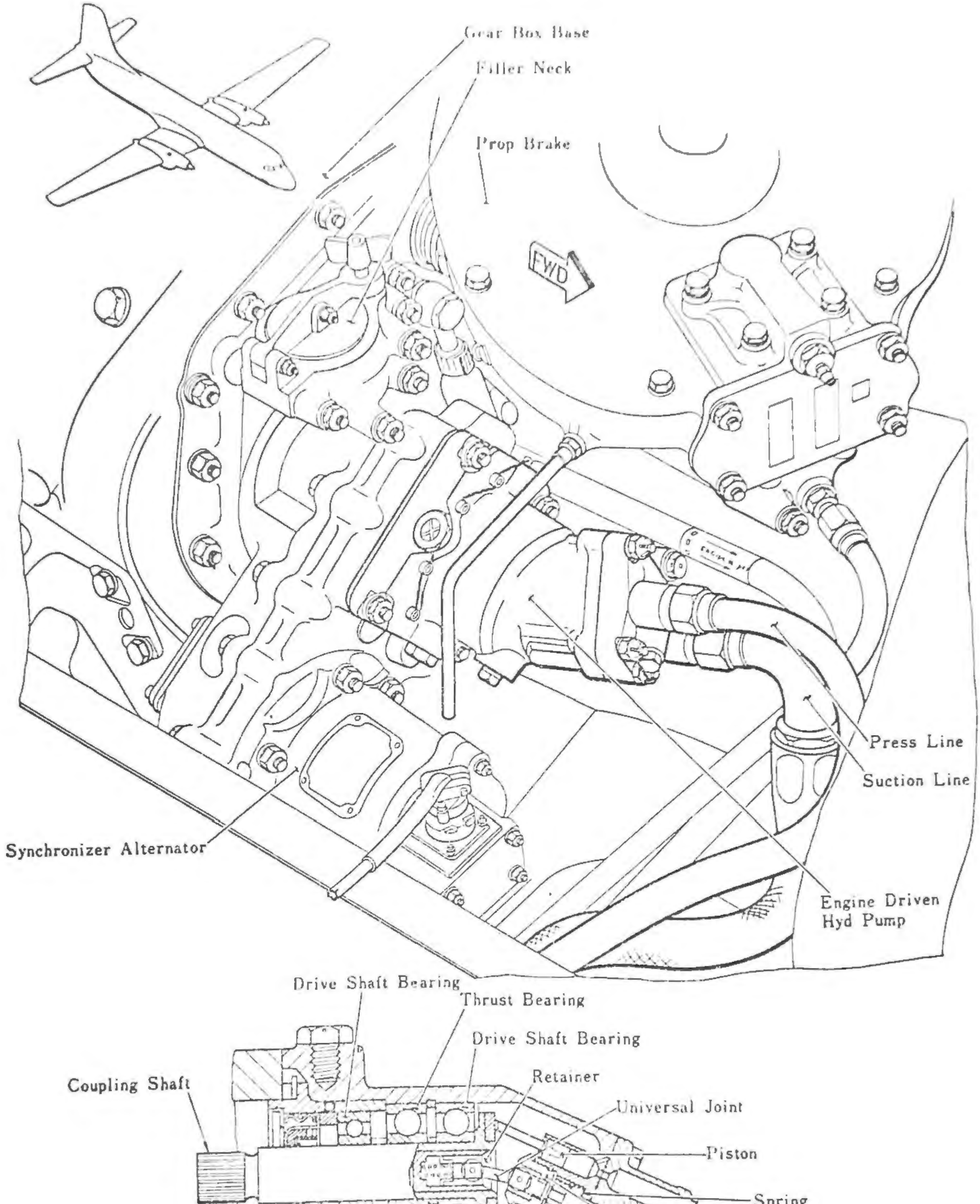
6.2.5 Unloading Manifold

(1) General

This is located just before the maintenance hole of the hydraulic compartment and is designed to regulate the pressure of the main hydraulic system. It is a combination of a manifold, an unloading valve, five check valves, a restrictor and a relief valve.

Hydraulic oil discharged from the engine driven pump goes into the unloading valve, passes through the dash pot check valve, and goes into the manifold where it is distributed among four circuits. One of the circuits leads to the regulator of the unloading valve.

If the system pressure reaches 3,050 to 3,100 psi, the regulator is



Engine Driven Hydraulic Pump

Figure 6–5

actuated, pushing the piston upward and letting the hydraulic oil from the pump escape directly into the return line. (Cut-out) To abate this operation, a restrictor is located in the sensing line. During the slow operation, however, the hydraulic oil from the pump enters the system and increases the pressure too much so that a relief valve is provided which lets the hydraulic oil escape.

The dashpot check valve mounted to the top of the unloading valve prevents the pressure oil from flowing back.

If the system pressure drops to 2,600 to 2,800 psi, the piston comes down and shuts off the return port so that the hydraulic oil from the pump begins to enter the system side again.

In this manner, the system pressure is maintained at 2,575 psi to 3,200 psi at all times through the repeated cut-in and cut-out of the unloading valve.

(2) Operation Check

Connect the hydraulic test stand and ground power unit to the aircraft.

(A) Set the pressure of the hydraulic test stand to 3,000 psi and the flow rate to 10 GPM.

(B) Increase the pressure gradually.

(C) Check that the pressure gage of the test stand drops from 3,050 to 3,100 psi quickly to 0 psi or its vicinity.

(D) Then, check that the hydraulic pressure gage of the aircraft indicates to psi.

(E) While keeping close watch on the indication of the hydraulic pressure gage of the aircraft, make sure that the indication increases quickly to 2,700 psi or its vicinity.

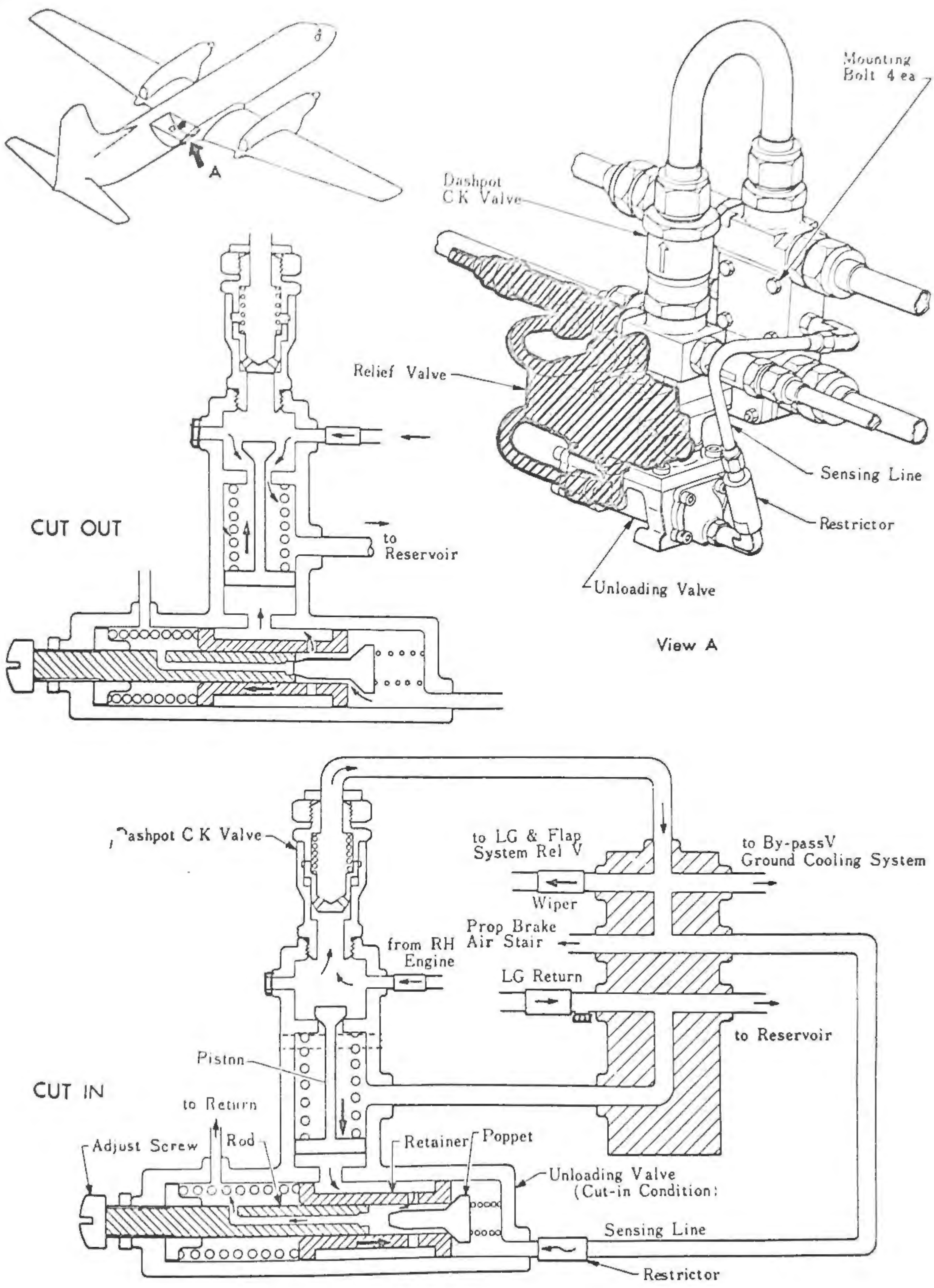
NOTE: After connecting the test stand, check that the emergency shut-off valve is in opened position.

6.2.6 By-pass Valve

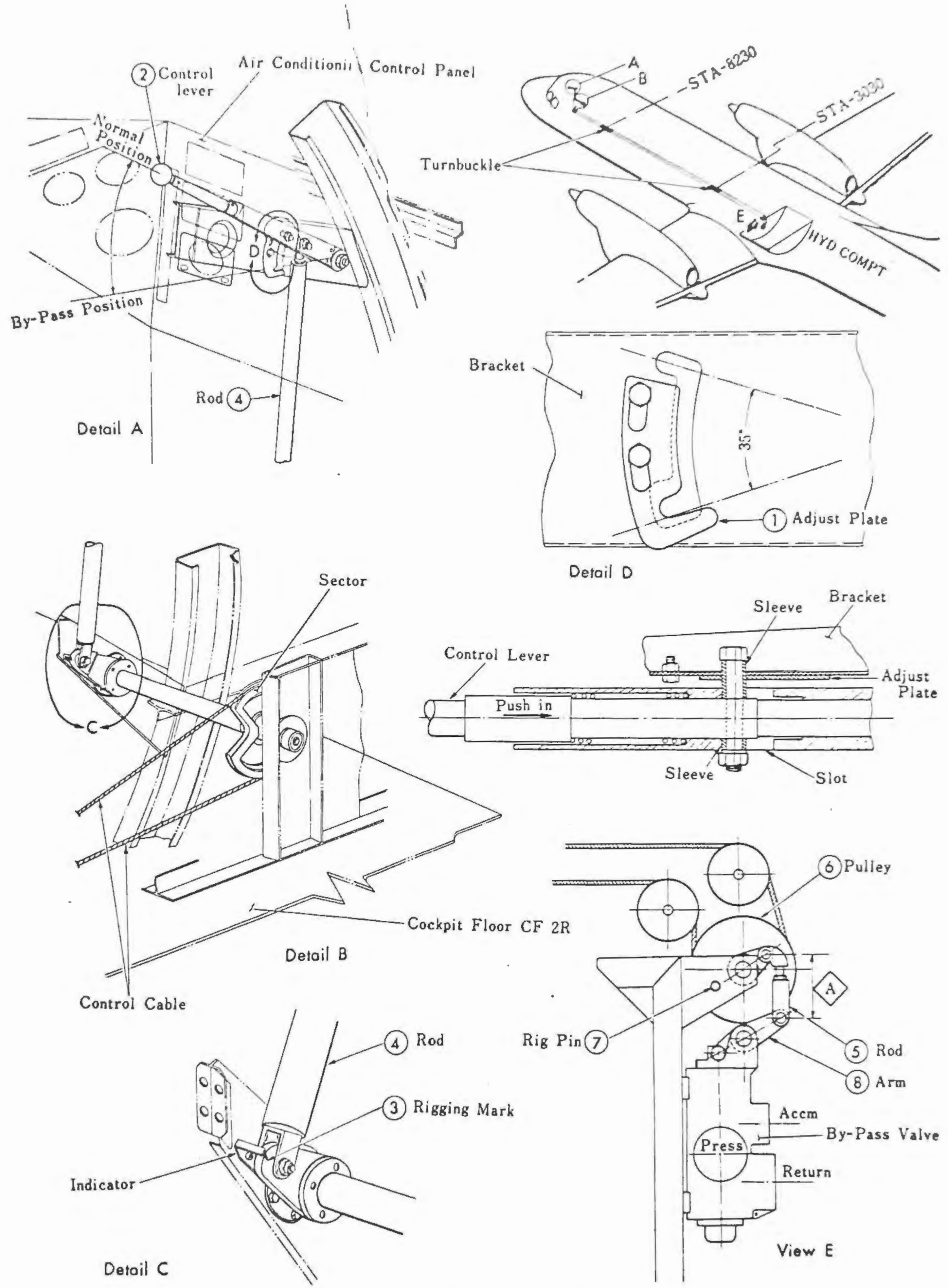
(1) General

This valve is located on the forward wall of the hydraulic compartment and is operated through a cable by the by-pass valve control lever on the right console of the cockpit. The by-pass valve has three ports, "Pressure", "Return" and "Accumulator".
The hydraulic oil from the unloading manifold goes into the "pressure" port and hydraulic oil from variable pump goes into the "Acc" port.

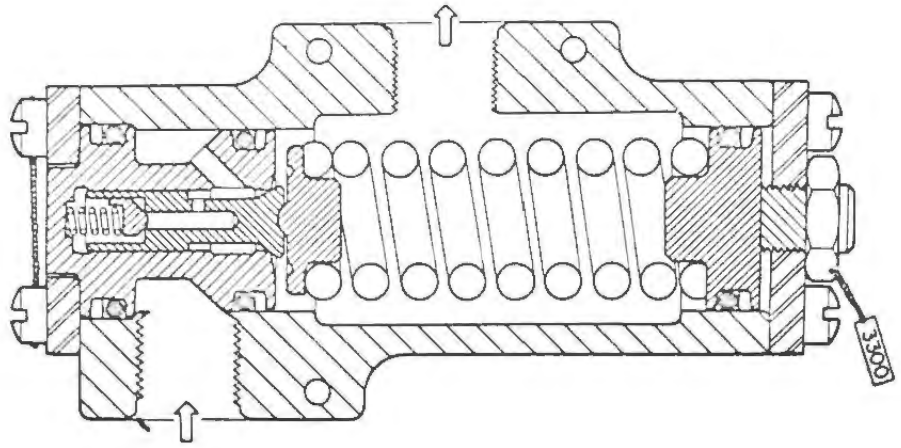
With the valve at "Normal", the pressure port and the accumulator



Unloading Manifold
Figure 6–6



By-pass Valve Control System-Rigging
Figure 6–7



Hydraulic System Relief Valve

Figure 6–8

6.2.8 System Accumulator

Two accumulators are located just behind the maintenance hole of the hydraulic pressure compartment.

It is of round diaphragm type and stores approx. 0.55 gal of 3,000 psi hydraulic oil.

With the by-pass valve at "Normal", it operates as an ordinary system accumulator. At "By-Pass", it operates as an emergency accumulator for normal brakes.

6.2.9 Auxiliary System

(1) General

This system consists of an auxiliary pressure source using an emergency motor driven hydraulic pump, piping system and electrical control system.

The reservoir it uses is common to that of the main system but the suction port of the emergency side is lower than that of the main side so that even if hydraulic oil in the main system runs short, 7.8 liters of hydraulic oil can be used.

Power supply for the emergency pump is taken from the DC emergency bus. With the emergency hydraulic pump switch at "ON" or with the stairway selector switch at "Up" or "Down", the pump starts running and the emergency hydraulic pump indicating light (amber) comes on.

The hydraulic oil pressurized by the emergency pump is passed through the filter and is divided among three systems. Among them, there is a line which leads to the emergency pump relief valve. The pressure is regulated by this relief valve. Each of these lines is provided with a check valve. Except for the emergency brake they are connected to the normal system lines, except the emergency brake system. (All return lines are common to the main system.)

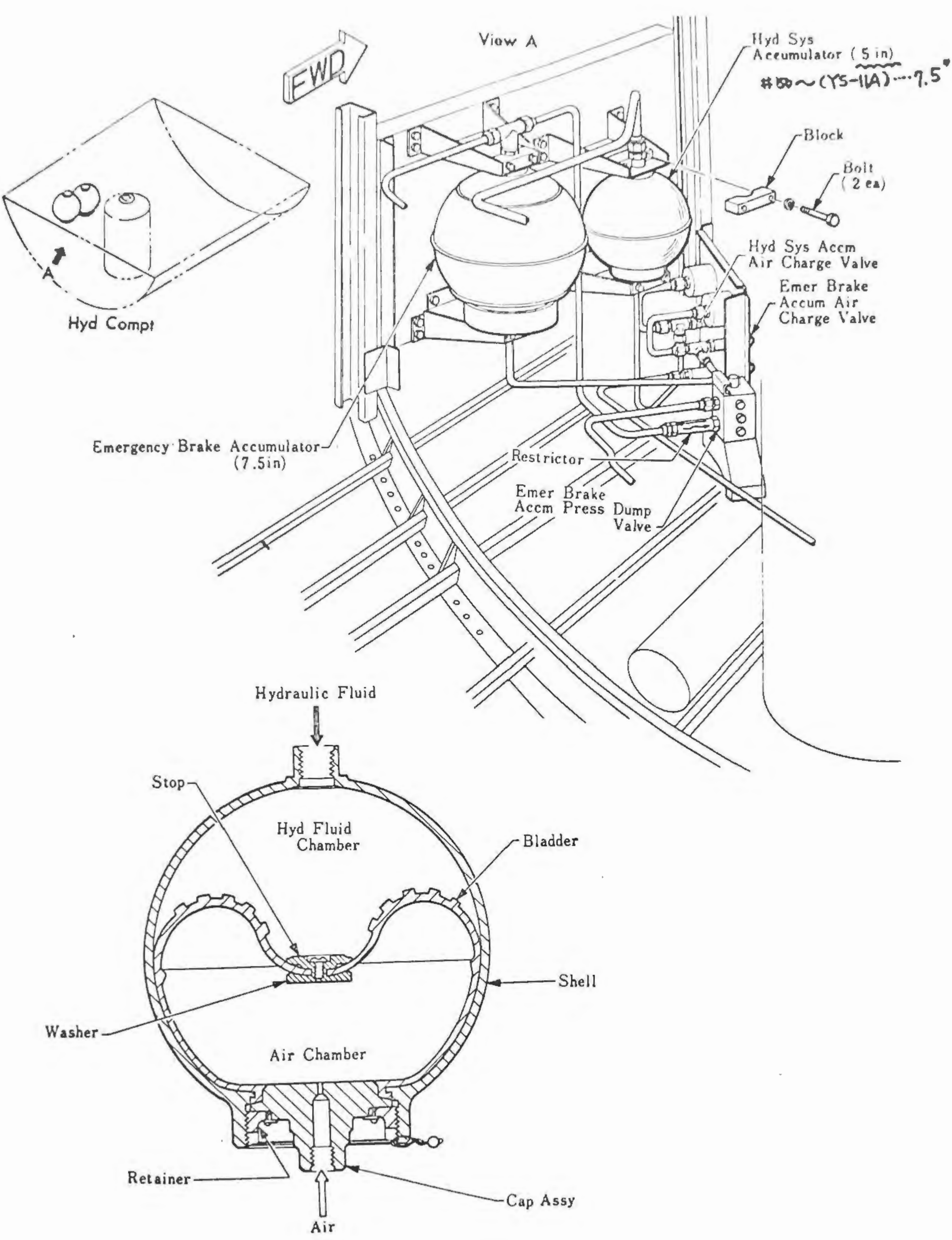
The purposes of this system are as follows: The system can be operated even with the by-pass lever at "By-Pass".

(A) As normal hydraulic pressure source

- a. For operation of emergency brake system
- b. For operation of stairway in the event of engine failure
- c. For servicing work

(B) As emergency hydraulic pressure source

- a. For operation of landing gear control, steering and flap systems.


View A
FWD
Hyd Sys Accumulator (5 in)
#50~(YS-11A)···7.5"
Block
Bolt (2 ea)
Hyd Sys Accm Air Charge Valve
Emer Brake Accum Air Charge Valve
A
Hyd Compt
Emergency Brake Accumulator (7.5in)
Restrictor
Emer Brake Accm Press Dump Valve
Hydraulic Fluid
Stop
Hyd Fluid Chamber
Bladder
Shell
Washer
Air Chamber
Retainer
Cap Assy
Air

Hydraulic System Accumulator

Figure 6-9

b. For operation of normal brake system

(2) Operation Check

Connect the external power supply to the aircraft.

(A) Check that the emergency brake accumulator low pressure warning light is ON.

(B) Measure the time between when the emergency hydraulic pump switch is set to "ON" and when the low pressure warning light goes out. The time shall be less than one minute.

(C) Run the emergency pump for another minute. Check that the emergency accumulator pressure is 3,000 to 3,050 psi.

6.2.10 Emergency Hydraulic Pump

The pump is a Vickers product. It is a constant-discharge pump driven by a 28V DC motor located in the rear of the hydraulic compartment, to the right of the hydraulic reservoir. The discharge capacity is 1.1 GPM at 3,000 psi.

6.2.11 Emergency Hydraulic Pump Relief Valve

Located the side of ground cooling fan Priority valve of the air conditioning compartment, it regulates the pressure of the auxiliary system.

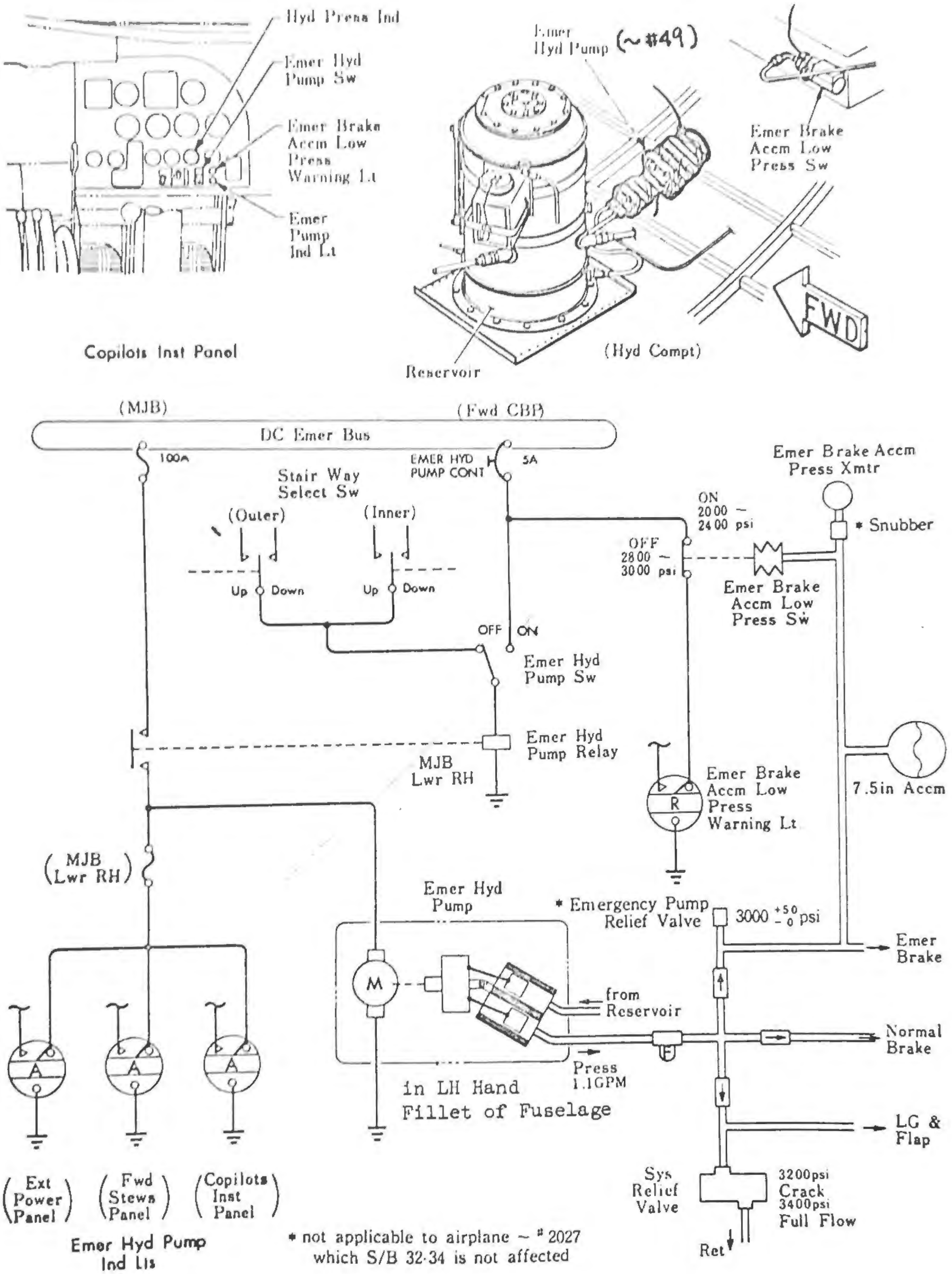
The relief pressure is $3{,}000^{+50}_{-0}$ psi.

6.2.12 Indicating System

As indicators for the hydraulic pressure system, the following are provided on the copilot flight instrument panel.

Hydraulic quantity indicator
Hydraulic pressure indicator
Emergency brake accumulator low pressure warning light

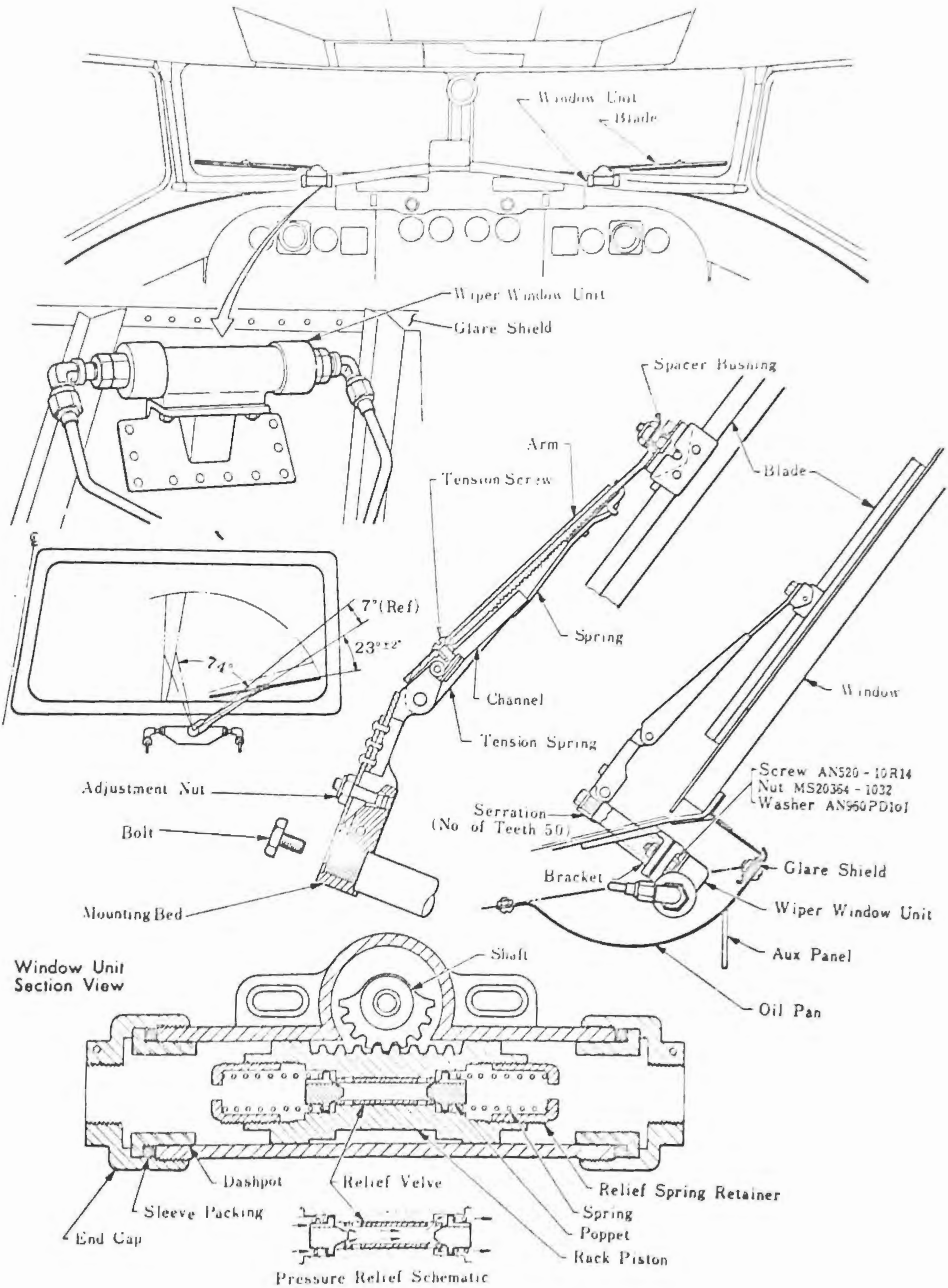
NOTE: Refer to the Instrument System.



* not applicable to airplane ~ # 2027 which S/B 32-34 is not affected

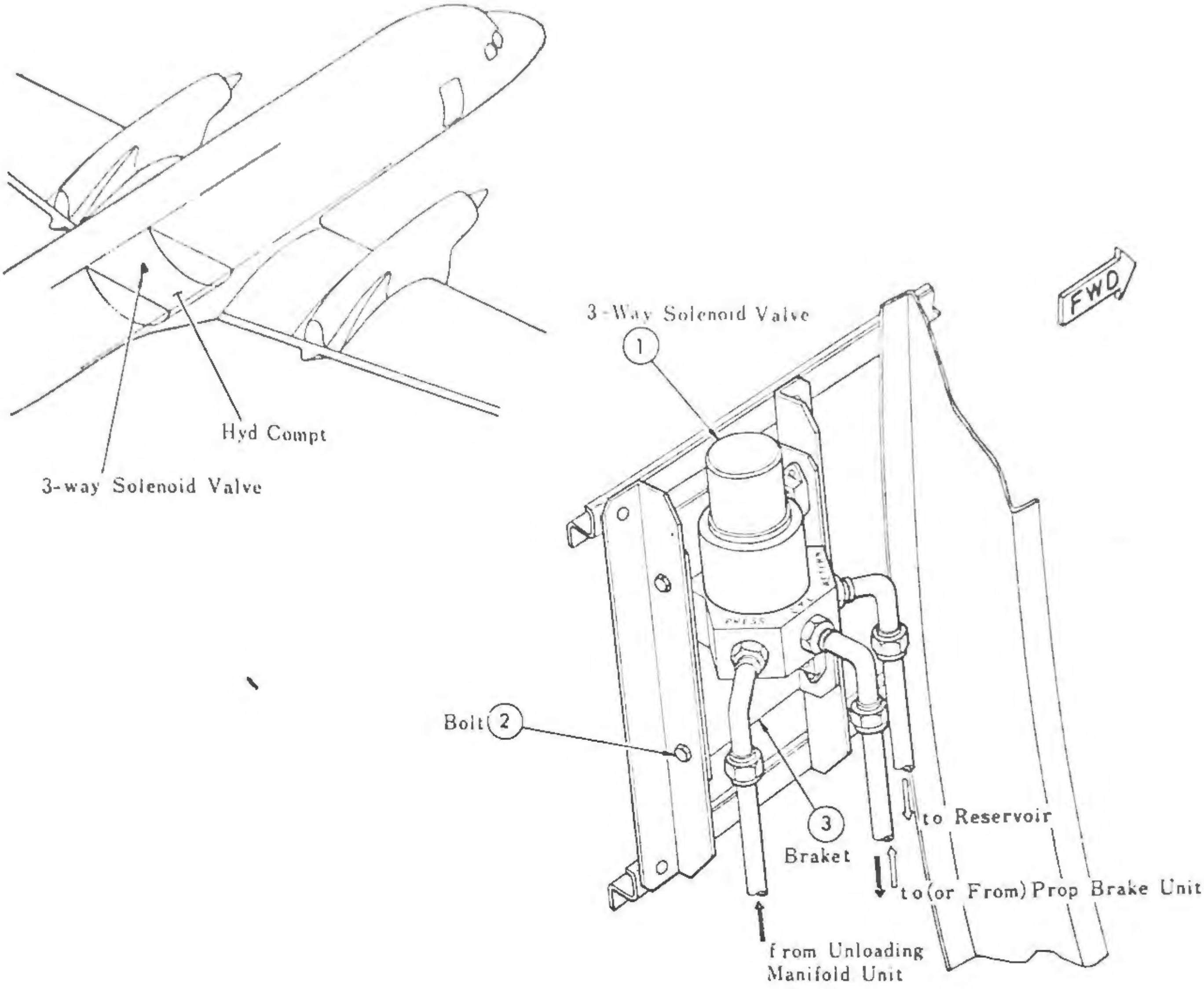
Emergency Hydraulic Pump Control System

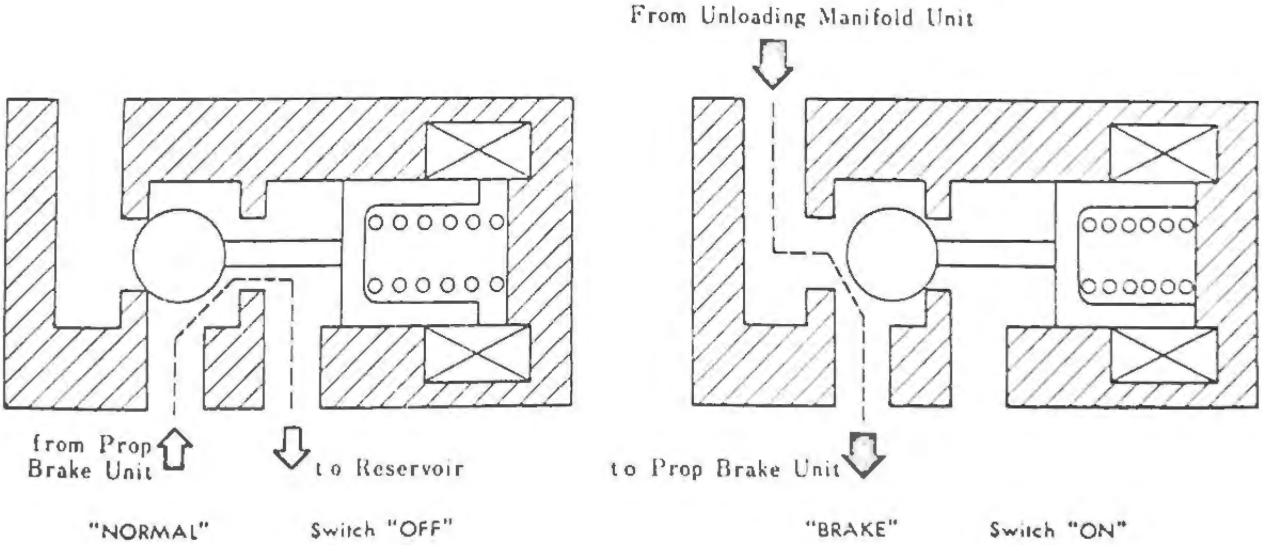
Figure 6–10



Wiper Window Unit and Wiper Blade

Figure 6-12





3-way Solenoid Valve Schematic Section View

Prop Brake Solenoil Valve Section View
Figure 6–16

6.13 Propeller Failure

6.13.1 Propeller Overspeed

If a propeller shows any signs of obvious malfunctioning or overspeeding, carry out the feathering procedure immediately.
If the propeller will not feather either manually or automatically, reduce airspeed immediately as much as possible.
A further feathering attempt should be made.
If unsuccessful, descend as low as possible, keeping low airspeed as much as possible.
At the minimum safe altitude, make another attempt to feather at a safe low speed.
While 16,500 r.p.m. in the overspeed limit for 20 seconds, any speed above 15,000 r.p.m. for full throttle, or that over the normal r.p.m. for part throttle, lasting for more than a few seconds, could be considered as overspeed; and, if there is any doubt, the propeller should be feathered.
Propeller windmilling characteristics are a function of true airspeed and descending to a lower altitude will give a slower rotation for the same indicated airspeed. Therefore, in any cases or failure to feather, it is essential to reduce airspeed and altitude as quickly as possible.

6.13.2 Failure to Feathering

In the event of a propeller failure to feather, a true airspeed of 227 kts must not be exceeded in order to prevent engine overspeed. In this case, the limitation on the strength of the fuselage also must be taken into account. Refer to Section 5.7.4, Chapter 5.

6.13.3 Failure of Low Stop

If the low stop unsafe light or the below low stop light come on in flight for any reason, check that the low stop lever is in FLIGHT position.
If these lights are on though the low stop lever is in FLIGHT position, pay full attention, if necessary.
During approach to land, sufficient power should be used to ensure that the propeller is kept above the switch set at 12°, although the pitch coarsening system will still be effective.

6.13.4 When High Stop Fails to Engage

If the high stop unsafe light comes on over the true airspeed of 187 kts, the propeller emergency switch must be placed in EMERGENCY position before increasing the speed. If the high stop unsafe lights are still on even after this procedure, the true airspeed should not exceed 227 kts. In this case, also the limitation on the strength of the fuselage must be taken into account. Refer to Section 5.7.4., Chapter 5.
If the high stop remove light remains on at the true airspeed of more than 187 kts, make sure that the H.P. cock lever is not in LOCK OUT position.
If the light is still on even after the H.P. cock lever is moved into FUEL ON position, carry out the aforementioned procedure.

port are connected to each other, and the pressure of hydraulic oil from variable pump is fed to the hydraulical operated system (except for the emergency brake).

At "By-Pass", the pressure port and the return port are connected to each other and the system pressure escapes to the return line, decreasing the loads to the unloading valve and R.H. engine driven pump. Under this condition, the L.H. side variable pump feeds pressure oil to the accumulator and the normal brake system.

(2) Adjustment

The rigging points are shown in Fig. 6-7.

(A) Accomplish adjustment at the "Normal" position.

(B) Make sure that the cable tension is 29±4 lbs (70°F±0.4 lb/°F)

(C) Determine the length of the by-pass valve arm (8) by pressing it down by hand until response is felt.

(D) Adjust the position of the control lever by the adjust plate.

(3) Operation Check

Connect the hydraulic test stand and the external power unit to the aircraft.

(A) Set the pressure of the test stand to 3,000 psi.

(B) Operate the by-pass lever and check that there is no abnormal load

(C) Apply foot pressure on the brakes until the hydraulic pressure gage of the aircraft indicates 0, with the by-pass lever at "By-Pass".

(D) With the by-pass lever in "NORMAL", check that the pressure gage of the aircraft indicates 2,700 psi. Then, move the lever to "BY-PASS".

(E) Check that the indication of the pressure gage of the test stand decreases quickly from 2,700 psi to 0 psi and that the hydraulic pressure gage of the aircraft stays near 2,700 psi.

6.2.7 System Relief Valve

The valve is mounted in front of the man hole in the hydraulic compartment to the left of the flap gear box. This provides system surge pressure relief and serves as a safety device when there is trouble in the unloading valve and the emergency hydraulic pump relief valve.

Opening pressure	3,160 psi
Full opening pressure	$3{,}300\ ^{+50}_{-0}$ psi

6.3 Windshield Wiper

6.3.1 General

On the front of the windshield, hydraulically driven wiper blades are provided to remove water and rain drops. The wiper control knob is located on the left console of the cockpit. The wiping speed of the wiper is adjusted by this control knob.

The wiping angle of the wiper blade is 74°. Even if one blade is frozen, the other one can continue its operation.

The wiper consists of:

(1) Window unit

(2) Control unit

(3) Speed control unit

6.3.2 Operation (Fig. 6-11)

If the speed control valve is opened, the hydraulic oil with pressure reduced to 2,000 psi by the wiper reducing valve goes into the control unit.

(1) The hydraulic oil acts on the right end of the lock valve, pushes the valve toward the left, and opens the oil path which leads to the window unit.

(2) At the same time, since the directional valve has the pilot valve held toward the left, it is pushed toward the left by hydraulic oil.

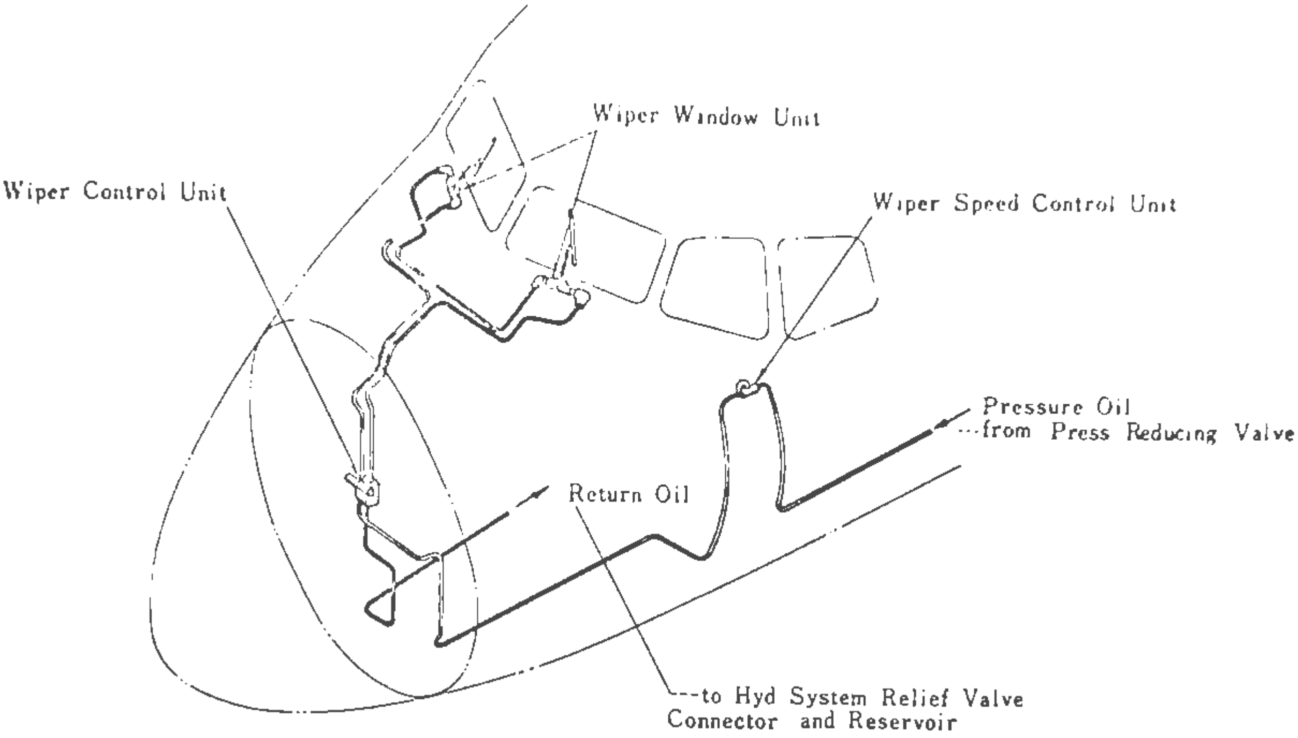
(3) As a result, the right side of the two oil paths from the lock valve to the window unit permits hydraulic oil flow, while the left side permits return flow.

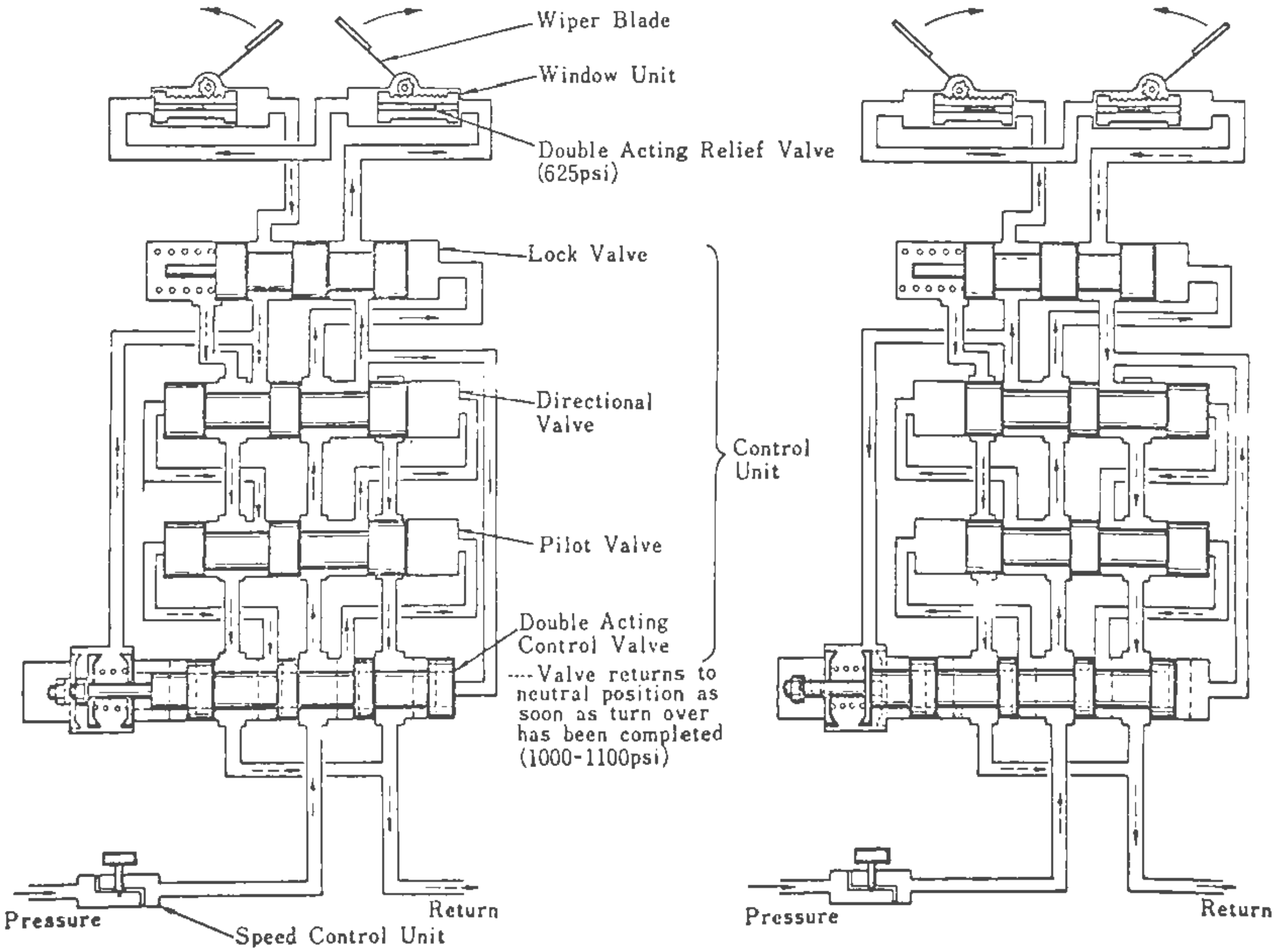
(4) The piston in the window unit is moved inward by hydraulic oil, while the wiper blades are rotated outward.

(5) If the piston in the window unit reaches its extreme end, the hydraulic pressure rises to 1,000 to 1,100 psi, acts on the right end of the double acting control valve, and pushes the valve to the left. This switches the hydraulic oil path to the pilot valve and directional valve in that order. Then, the control valve returns to the original neutral position and fixes the pilot valve.

The blades are moved inward.

(6) If the speed control valve is closed, the directional valve is placed in freely movable condition because the oil pressure dies out. The lock valve is pushed to the right by a spring, closing the two oil





Wiper Hydraulic System Schematic

Figure 6–11

paths to the window unit, and stopping blades.

6.3.3 Operation Check

(1) The speed shall be 400 strokes or more with the speed control valve in fully opened position.

(2) It shall perform smooth operation even at 150 strokes or less.

(3) Even if one blade is held with fingers, the other shall be able to function normally.

NOTE: Sprinkle water over the front surface of the windshield before the check.

6.3.4 Window Unit

At the lower right and left ends of the auxiliary panel, is located the unit which contains a piston and wiper shaft in its body. At the end of the wiper shaft, a wiper blade is located. Inside the piston, a sleeve type relief valve is provided. This relief valve is a double acting relief valve. If the piston stops operation and the oil pressure exceeds 625±10 psi, this relief valve relieves pressure. Because of this function, even if one of the two units becomes inoperative, the other continues normal operation. If both units reach the extreme end, the oil pressure becomes 1,000 to 1,100 psi because these units are arranged in series. The pressure acts on the control unit and switches the hydraulic and return oil paths.

This enables the wiper to repeat reciprocating operation.

6.3.5 Control Unit

This is a unit to switch the oil paths to the window unit and to enable the wiper blades to repeat reciprocating operation. It is located on the front of the seal wall in the upper part of the nose gear well.

It consists of the following four valves:

(1) Double Acting Valve

If the two pistons in the window units reach the extreme end and the oil pressure increases to 1,000 to 1,100 psi, the valve is pushed toward one side and switches the oil path leading to the pilot valve, thus reversing the direction of oil pressure to the window unit. If the window unit operation is switched, this valve returns to the neutral position and locks the pilot valve in that position.

(2) Pilot Valve

The oil paths to the directional valve are switched by this valve.

(3) Directional Valve

The oil paths to the window units and double acting valve are switched by this valve.

(4) Lock Valve

This valve locks the stationary window units to prevent their unnecessary motion.

6.3.6 Speed Control Unit

Located on the top of the pilot LH console, it controls the oil quantity by a needle valve and orifices and changes the operating speed of the wiper blades.

6.4 Ground Cooling System

6.4.1 General

This is an auxiliary system to be used when the aircraft is on the ground and no sufficient cooling ram air is available from the heat exchanger.

6.4.2 Operation

If the ground cooling fan switch of the RH console is set to "ON", the light (amber) comes on, the shut-off valve opened, and the hydraulic oil goes to the priority valve.

The priority valve is opened when the oil pressure reaches 2,100 psi, and the hydraulic oil drives the ground cooling fan. If the oil pressure drops to 1,900 psi, the priority valve is closed and the hydraulic oil blocked to secure brake pressure.

The two ground cooling fans are connected in series and the return line is provided with a restrictor (orifice) in order to subdue the pressure pulsation.

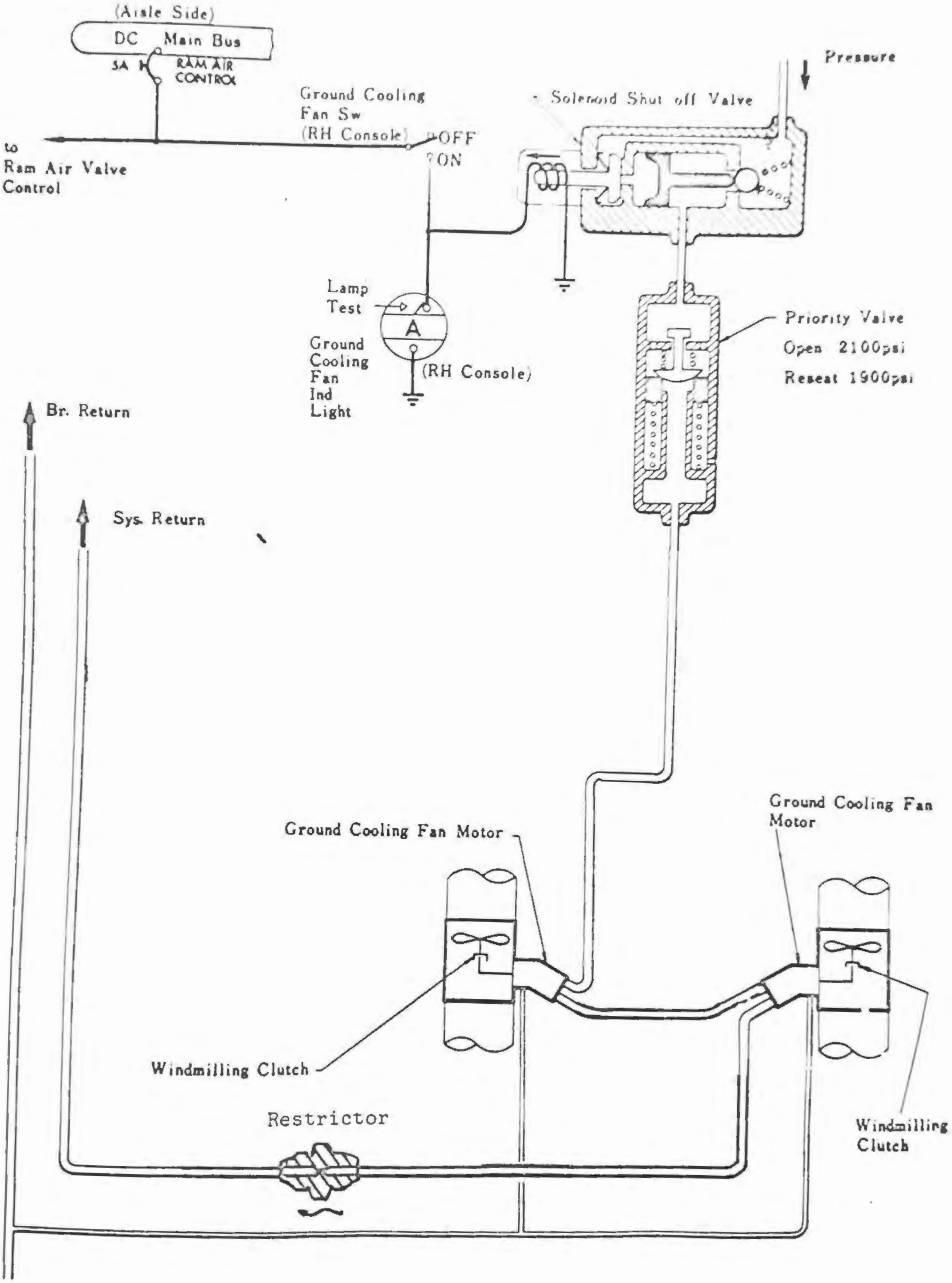
The ground cooling fan motors are approx. 50HP hydraulic motors and drive the fans mounted on the primary and secondary heat exchangers.

During the time the hydraulic motors are at rest, the fans alone can be idled by ram air.

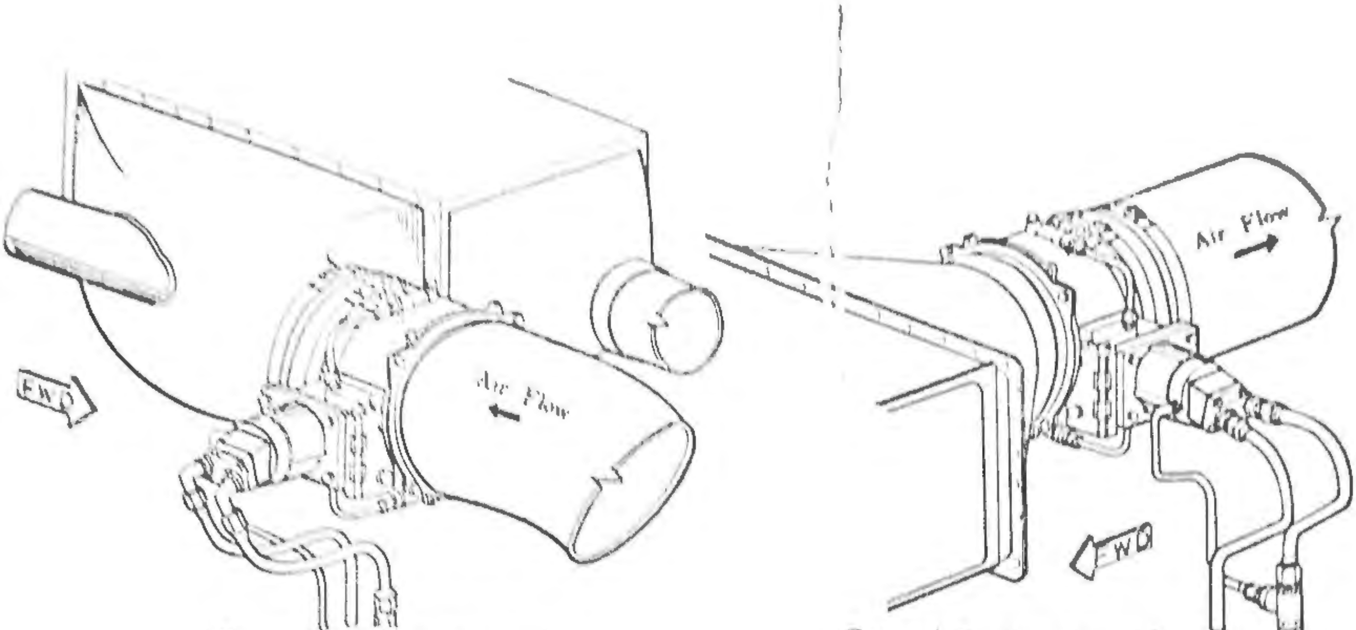
6.4.3 Operation Check

(1) Increase the oil pressure of the aircraft and check that the cooling fans start running at 2,100 psi.

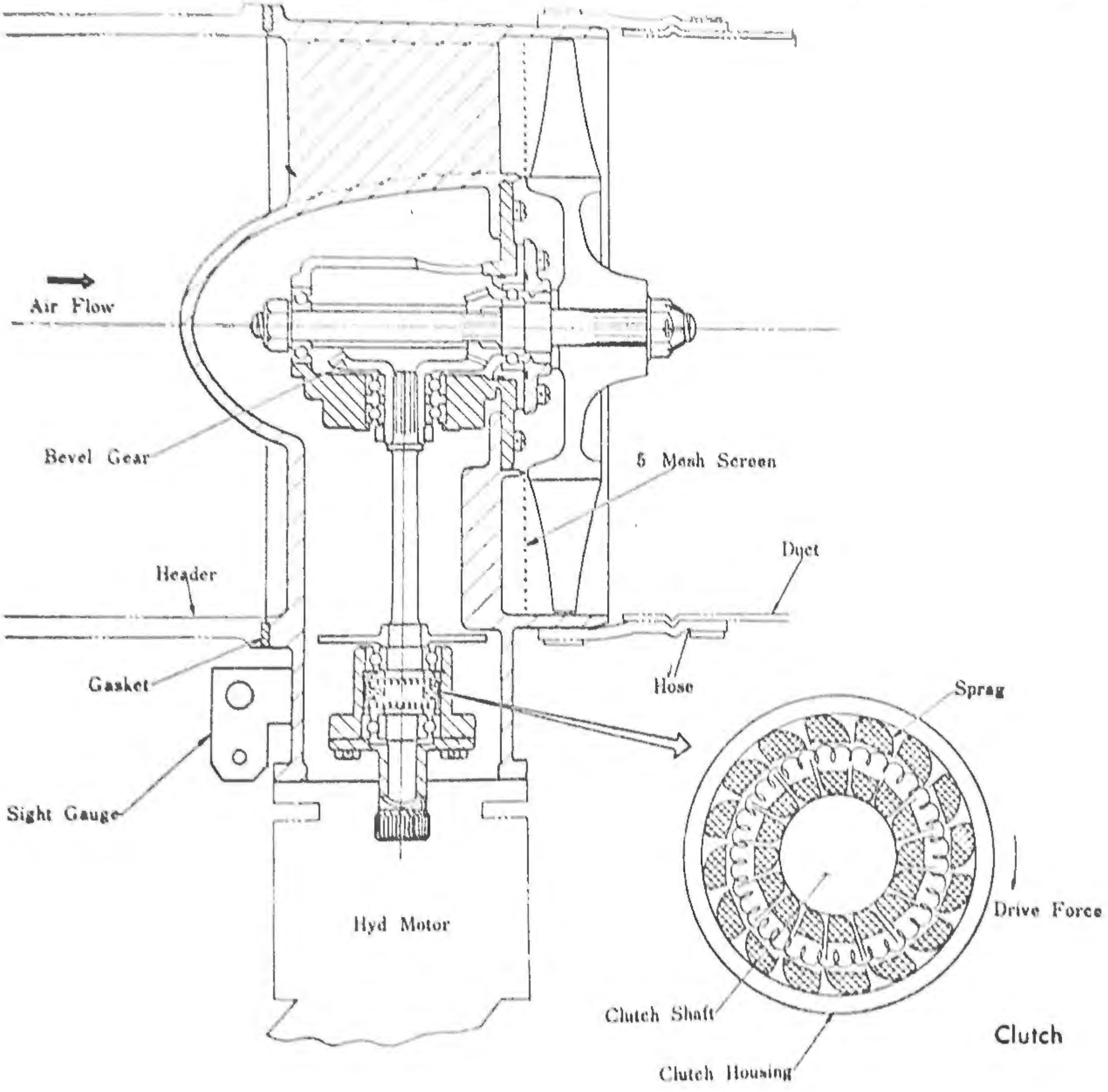
(2) Lower the oil pressure of the aircraft and check that the fans cease to rotate at 1,900 psi minimum.



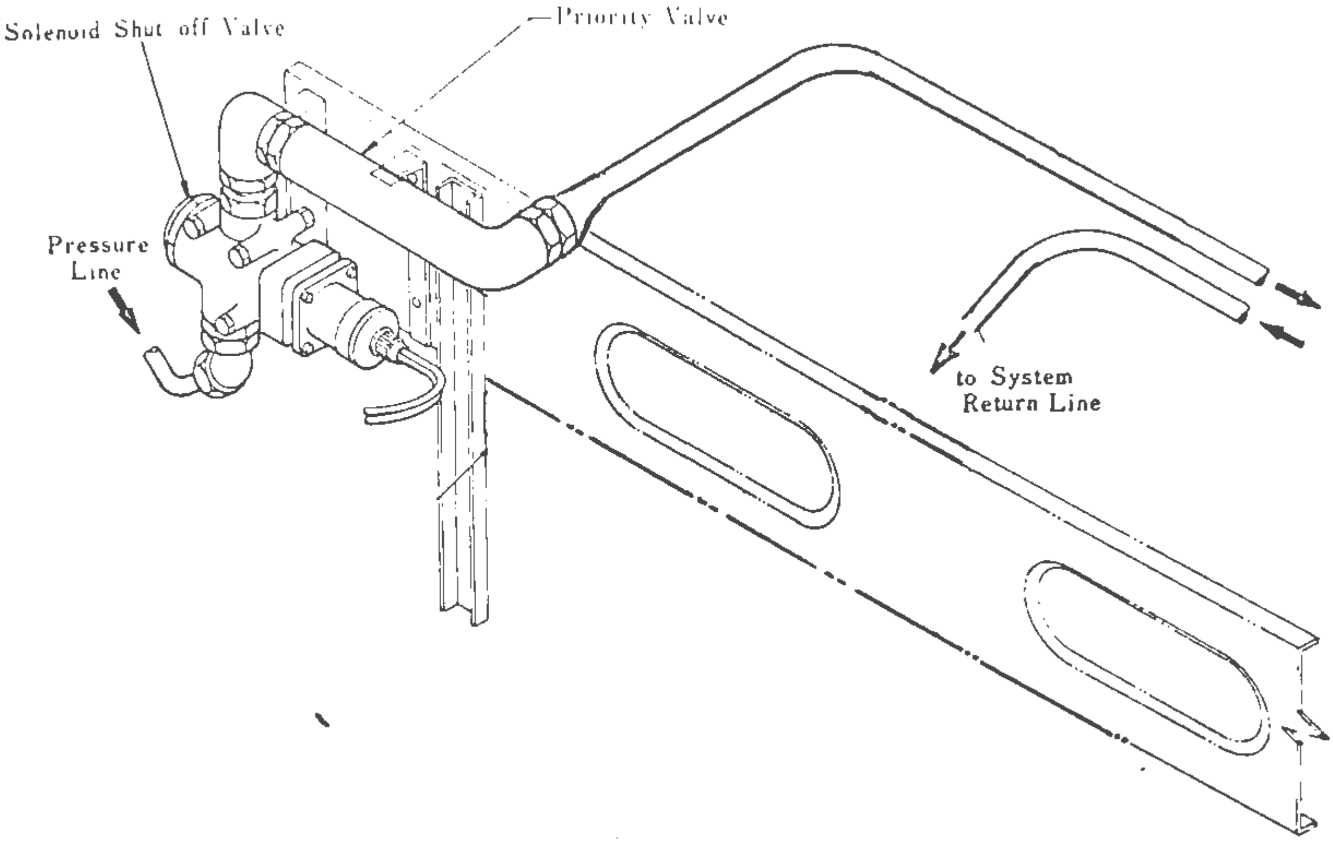
Ground Cooling System Schematic
Figure 6-13

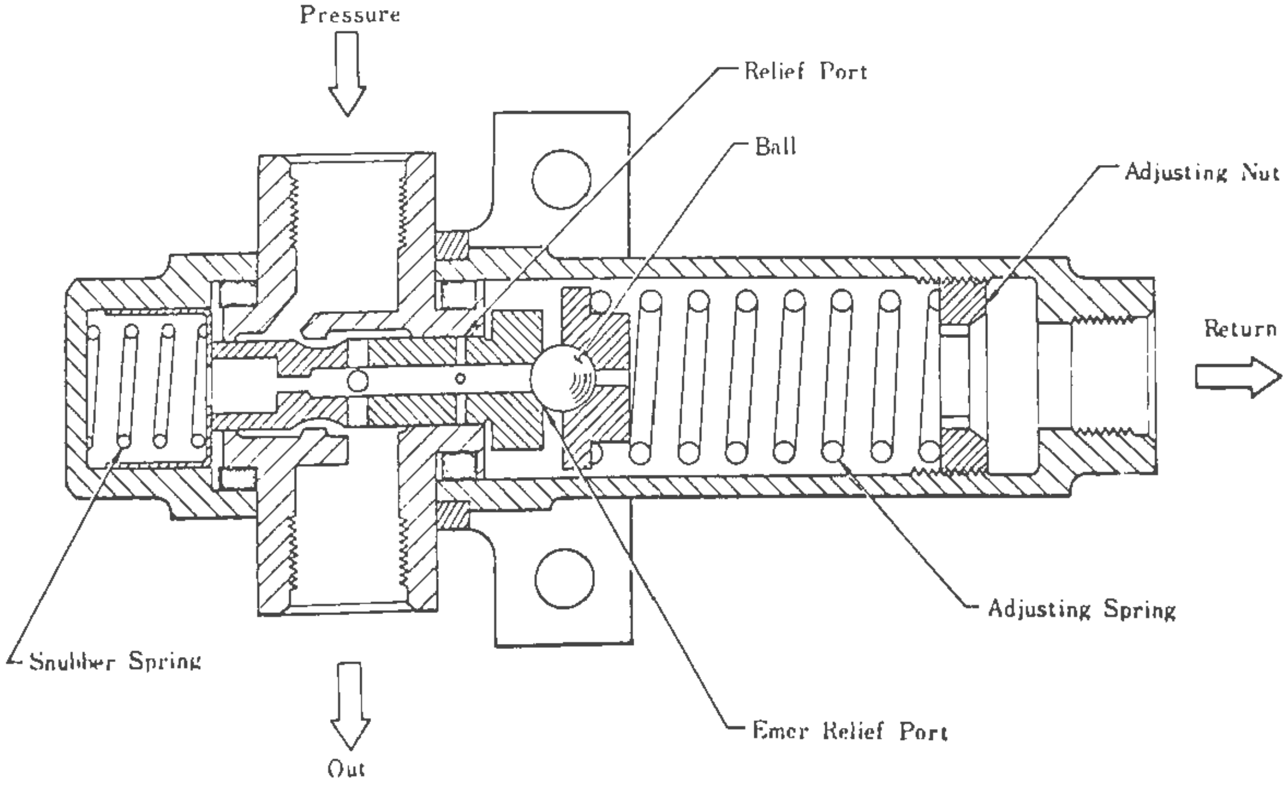


Ground Cooling Fan-Fwd Ground Cooling Fan-Aft



Ground Cooling Fan
Figure 6–14





Ground Cooling Hyd Pressure Reducing Valve

Figure 6-15

6.5 Propeller Brake System

6.5.1 General

The port propeller has a brake to stop the propeller in a short time. The brake assembly is located in the port gear box and holds the gear box drive shaft.

6.5.2 Operation

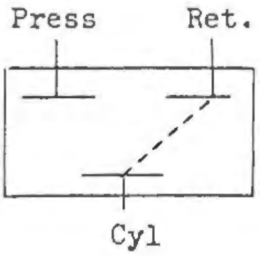
The system can be operated only when the aircraft is under the following conditions:

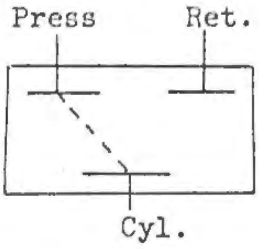
(1) Scissors relay Ground

(2) No. 1 eng. HPC Fuel off

If the propeller brake switch located at the left end of the auxiliary panel of the cockpit is set to "ON", the pressure port and cylinder port of the propeller are connected to each other.

Designed for solanoid operation, this control valve, operated by a solenoid, forms the following circuits:



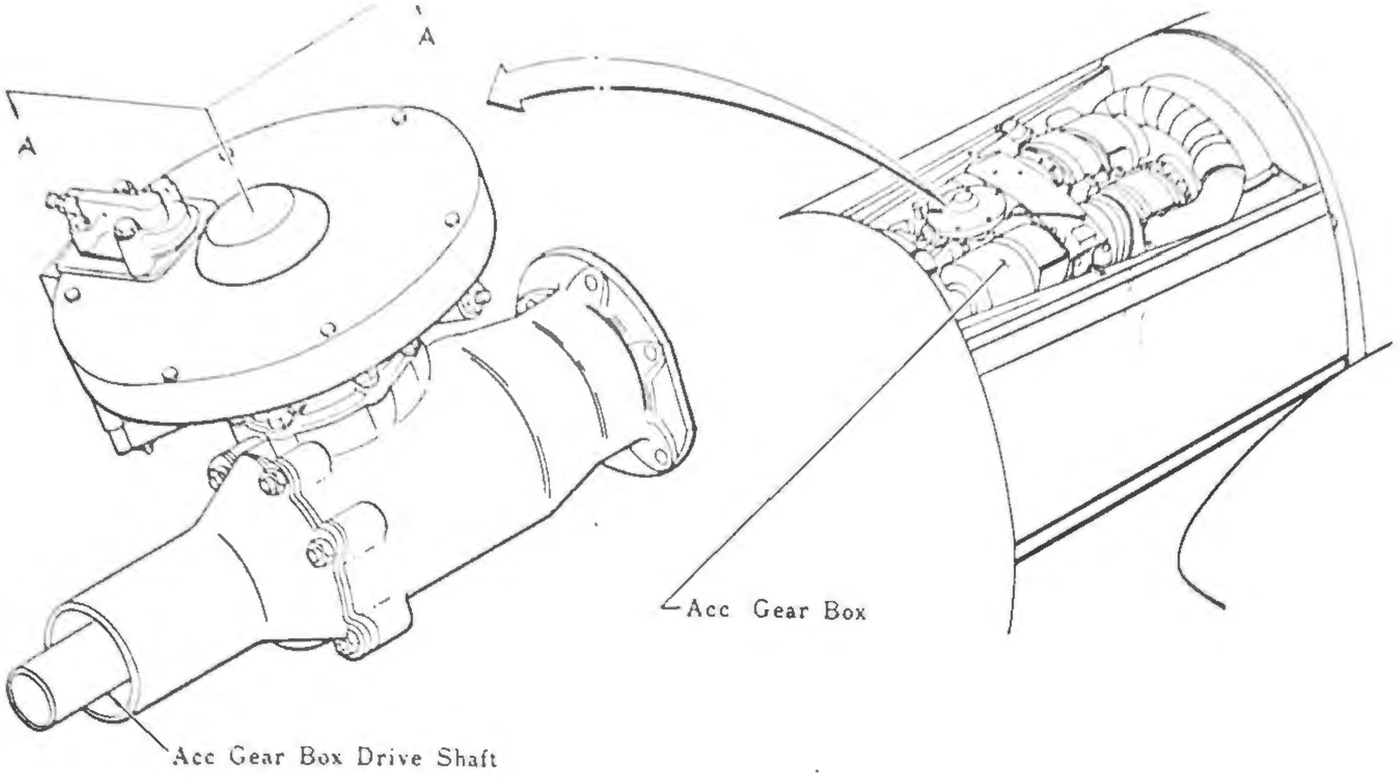


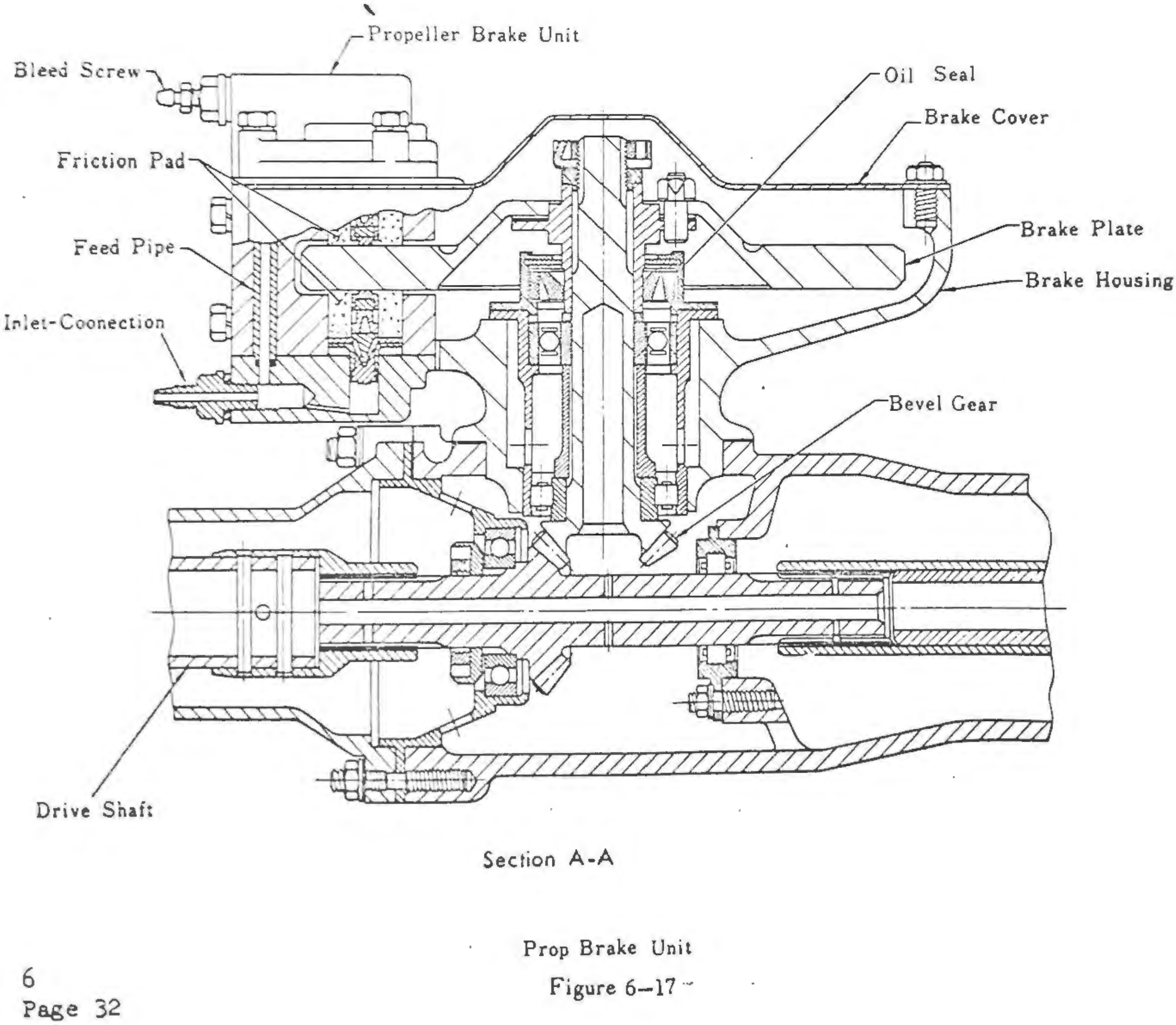
The hydraulic oil passed through the propeller brake solenoid valve is applied to the propeller brake unit of the gear box and controls the brake disc. This brake disc applies brakes on the propeller shaft through the gear box drive shaft.

6.5.3 Operation Check

(1) With the HPC lever at "Fuel Off" and the propeller brake switch at "ON", check that the propeller cannot be rotated by hand.

(2) With the HPC lever at "Fuel ON" and the propeller brake switch at "ON", check that the propeller can be rotated by hand.





Section A-A

Prop Brake Unit

Figure 6–17

6.6 Stairway System

6.6.1 General

The stairway system is operated hydraulically and controlled electrically. The stairway components include:

(1) Passenger entrance door and door actuating mechanism.

(2) Door lock mechanism

(3) Stairway assembly

(4) Platform assembly

(5) Hydraulic system

(6) Electrical system

(7) Emergency control system

The passenger entrance door is opened and closed as shown in Fig. 6-18 by a link mechanism installed under the floor. The door is actuated by a hydraulically operated cylinder. The door is locked in opened position by the stopper of the link mechanism located under the floor. In closed position, the door is locked and tightened to the aircraft by a latch rod built in the door. The latch rod of the door is actuated by a hydraulically operated door lock cylinder.

The stairway assembly is of three-fold type and is mounted on the attachment fitting under the floor (WP-850, BP-1000) by the bent head fitting located on the top of the stairway assembly. The stairway is retracted and lowered by a hydraulic cylinder (stairway actuating cylinder) mounted on the torque tube located at the end of the bent head fitting. The stairway has a hinge under the floor.

When it is retracted, it is erected in three folds so that a portion of the aisle floor plate must move together with the stairway. The floor plate which moves with the stairway is the platform assembly. In up position, the stairway is locked by a mechanical lock mechanism, but has no lock mechanism in down position.

The stairway is actuated by hydraulic oil supplied by the emergency hydraulic pump. The hydraulic circuit is connected to the landing gear down line.

The stairway can be controlled from both inside and outside the aircraft.

Inside the aircraft, the control switches and indicating lights are located on the forward stewardess panel. Outside the aircraft, they are located at the external power supply connection panel on the nose end of the fuselage.

A. Forward stewardess panel

(A) Mechanical lock handle

(B) Stairway selector switch

(C) Indicator lights

Emergency hydraulic pump	Amber
Prop brake	Green
Limit switch failure warning	Red

B. External power supply connection panel

(A) Stairway selector switch

(B) Indicator light

Emergency hydraulic pump	Amber

Power supply for the electrical system is taken from the DC emergency bus. The control circuit is formed only when the aircraft is on the ground.

When there is trouble in the hydraulic and electrical systems, the stairway can be brought down by an emergency control system. Unlock the door by the manual handle, push the door open by hand, and push the stairway down.

6.6.2 Operation of Stairway

The aircraft must be in the following conditions.

A. Scissors relay	Ground
B. L/G selector lever	Down
C. HPC lever	Fuel off
D. Prop brake	ON

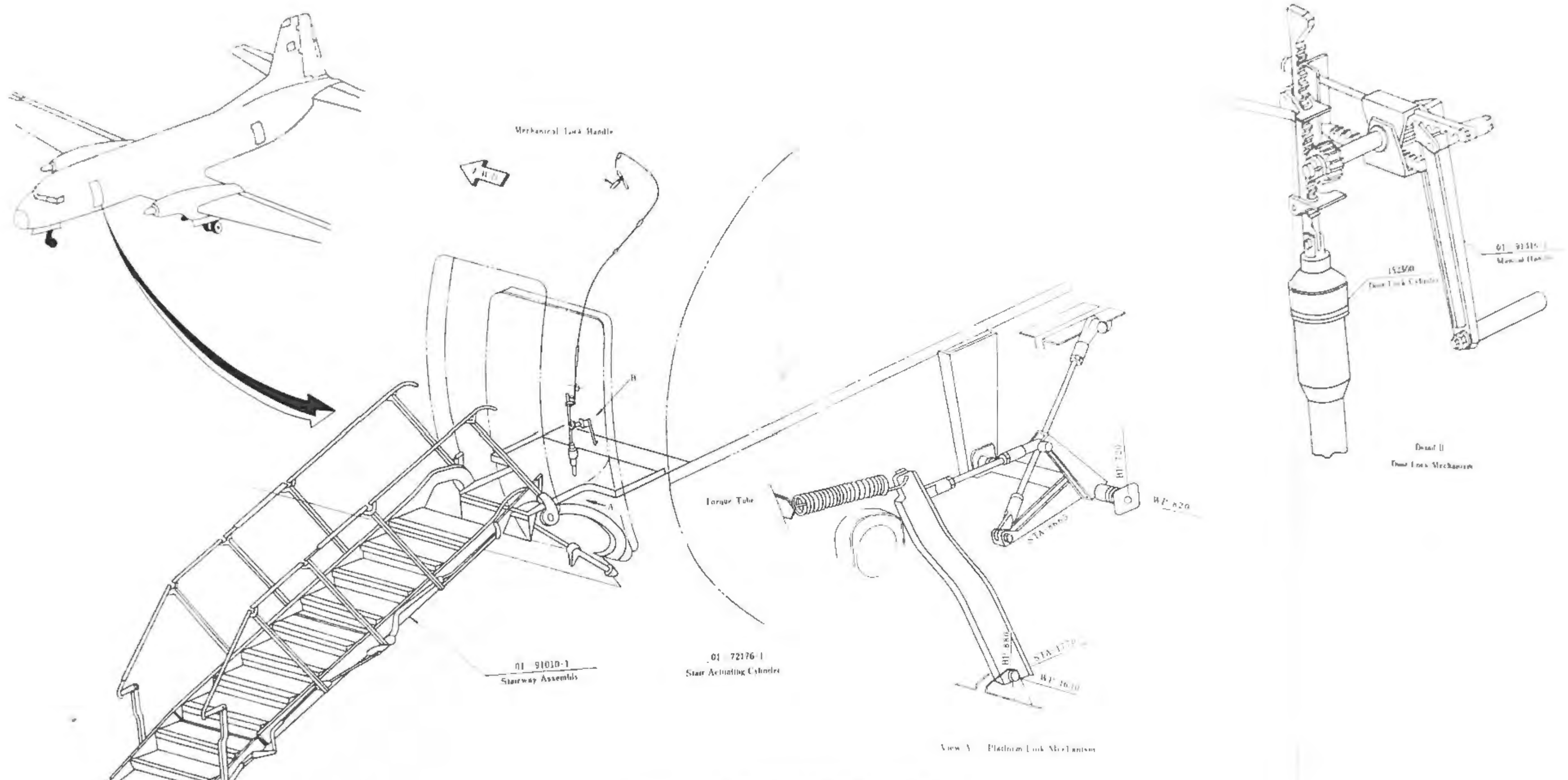
(Otherwise, the electrical and hydraulic circuits are not formed.)

(1) Stairway Down

Operation from inside the aircraft

(A) If the mechanical lock handle is set to "Unlock", the door lock limit switch is set to ON and the door open warning light (amber) of the cockpit comes on.

(B) If the stairway selector switch (momentary switch) is set to "Down", the emergency hydraulic pump relay is energized, the



Arrangement of Air Stair Mechanism

Figure 6–18

latch rod.

If the door is locked by the door lock cylinder, the door lock limit switch is set to OFF at the stroke end and the emergency, stopping the hydraulic pump. At the same time, the selector valve is returned to the neutral position.

Then, the indicator lights (amber) of the control panel and the cockpit go out.

Next, the stairway selector switch is set to "OFF".

(C) Mechanical handle "Lock"

Then, the door open warning indicator light (amber) of the cockpit goes out.

Operation from outside the aircraft

The operation is the same as that from inside the aircraft. The only difference is that the last mechanical lock handle cannot be locked.

6.6.3 Component Mechanisms

(1) Door and Door Mounting

The passenger entrance door has no pressure lock and open lock mechanisms employed for the other doors.

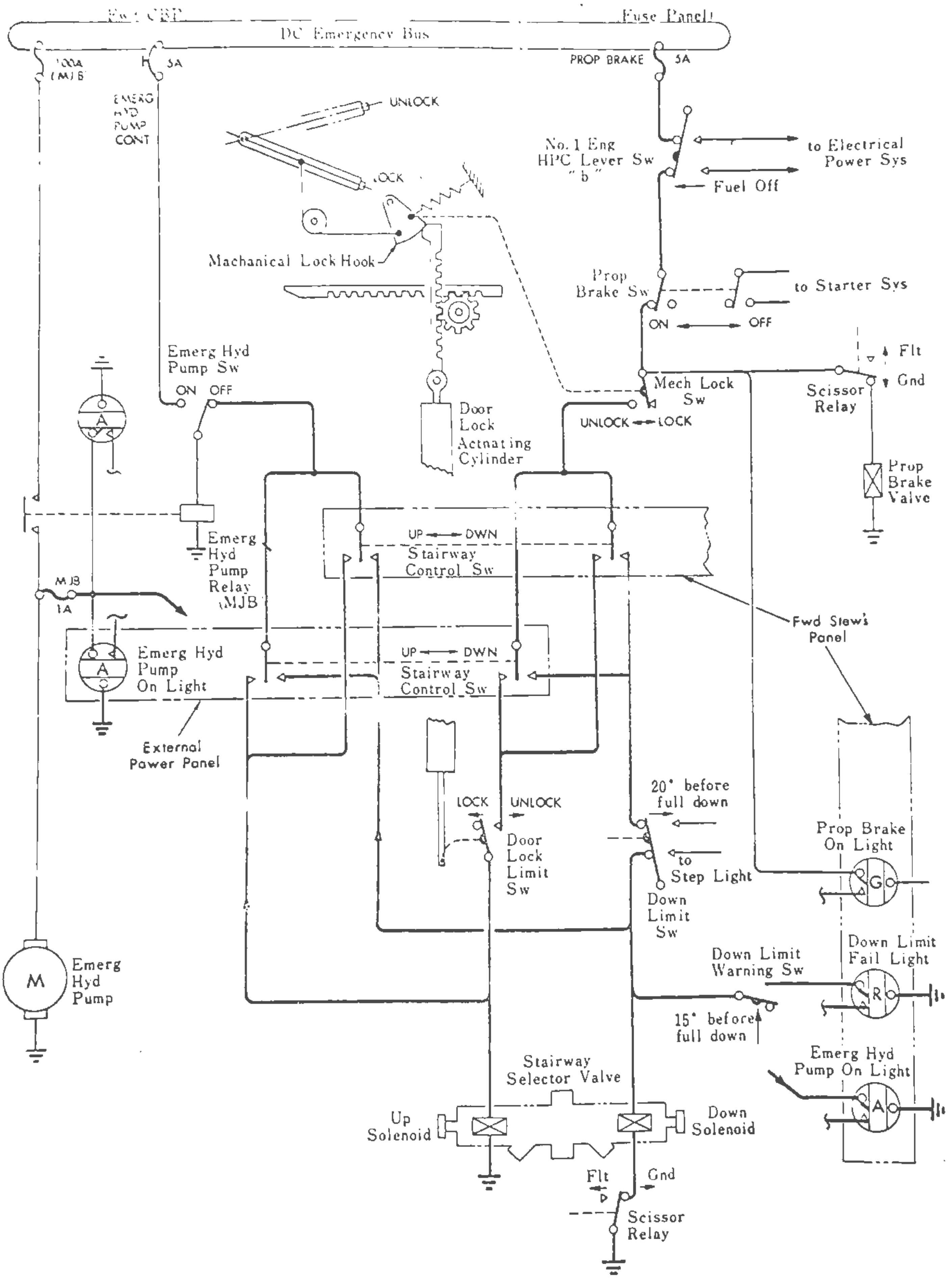
Each peripheral side of the door is provided with a roller to facilitate opening and closing the door. On the center surface (inside) of the door, a hinge is located which is mounted on the aircraft by a large curved arm. On the lower surface of the door, a door actuating mechanism lever is located.

(2) Door Lock Mechanism

The passenger entrance door is locked in closed position by a latch rod as in the case of the other doors. There are 10 latch rods in total.

The aircraft is provided with, a hydraulically operated door lock cylinder. This cylinder rod is provided with a rack. Two push-pull rods, which are moved by a pinion system engaging with the rack, extend toward the door. One is provided for locking the door, while the other is for unlocking the door.

The door is provided with a push-pull rod having a rack which is pushed by the push-pull rods on the aircraft. The pinion, which is engaged with the rack, rotates and the crank mechanism coaxial with this rotates the torque tube which moves the latch rod and performs lock-unlock operation.



Stairway Control Electric Schematic

Figure 6–20

Down side	Guide rail
Up side	Under the aircraft floor

The hand rail and link mechanism are employed to fold the stairway when it is operated. The hand rail support posts are mounted on the stairway proper and are provided with oilless bearings to permit free rotation round the mounted points. These are operated by rollers at the bottom end of the first support post assembly. When the stairway proper is driven by the stairway actuating cylinder, the rollers move along the guide rail under the floor of the aircraft. As a result, the stairway proper and the hand rails are folded into three by their link mechanism.

The step lights are controlled by the No. 1 down limit switch. If the entrance light switch on the forward stewardess panel is set to ON, the light comes on when the No. 1 down limit switch is cut off (emergency hydraulic pump stopped) at 20° before the fully down position.

(5) Emergency Control System

This is a system designed to lower the stairway manually when there is trouble in the hydraulic electrical system. The system, however, cannot be used to bring the stairway up.

Rotate by the manual handle the gear rotated by the rack of the door lock cylinder and release the door lock. This manual handle is usually accommodated in the upper shelf of the forward cargo compartment. Release the lock, push the door open by hand, and lower the stairway proper by hand.

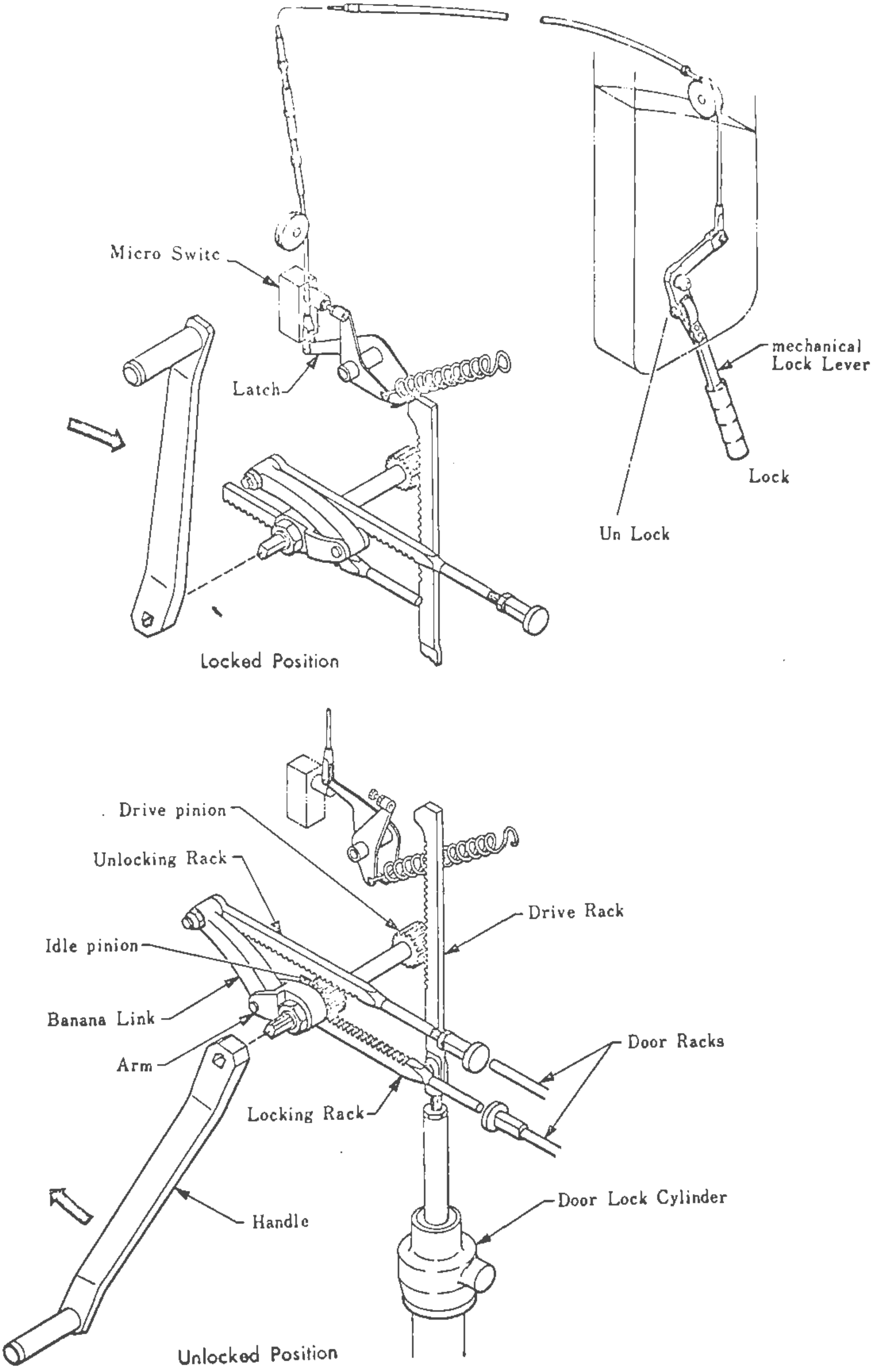
(6) Platform Assembly

This forms the passenger entrance aisle when the stairway is brought down. The platform link mechanism is kept in contact with the torque tube at all times by a spring so that the assembly is actuated along with the motion of the torque tube of the stairway proper.

6.6.4 Door Warning System

When the door is opened, the door opening warning light of the copilot's side panel of the cockpit comes on.

This system consists of under-floor door and above-floor door systems. The end of the latch rod of each door actuates a micro switch.

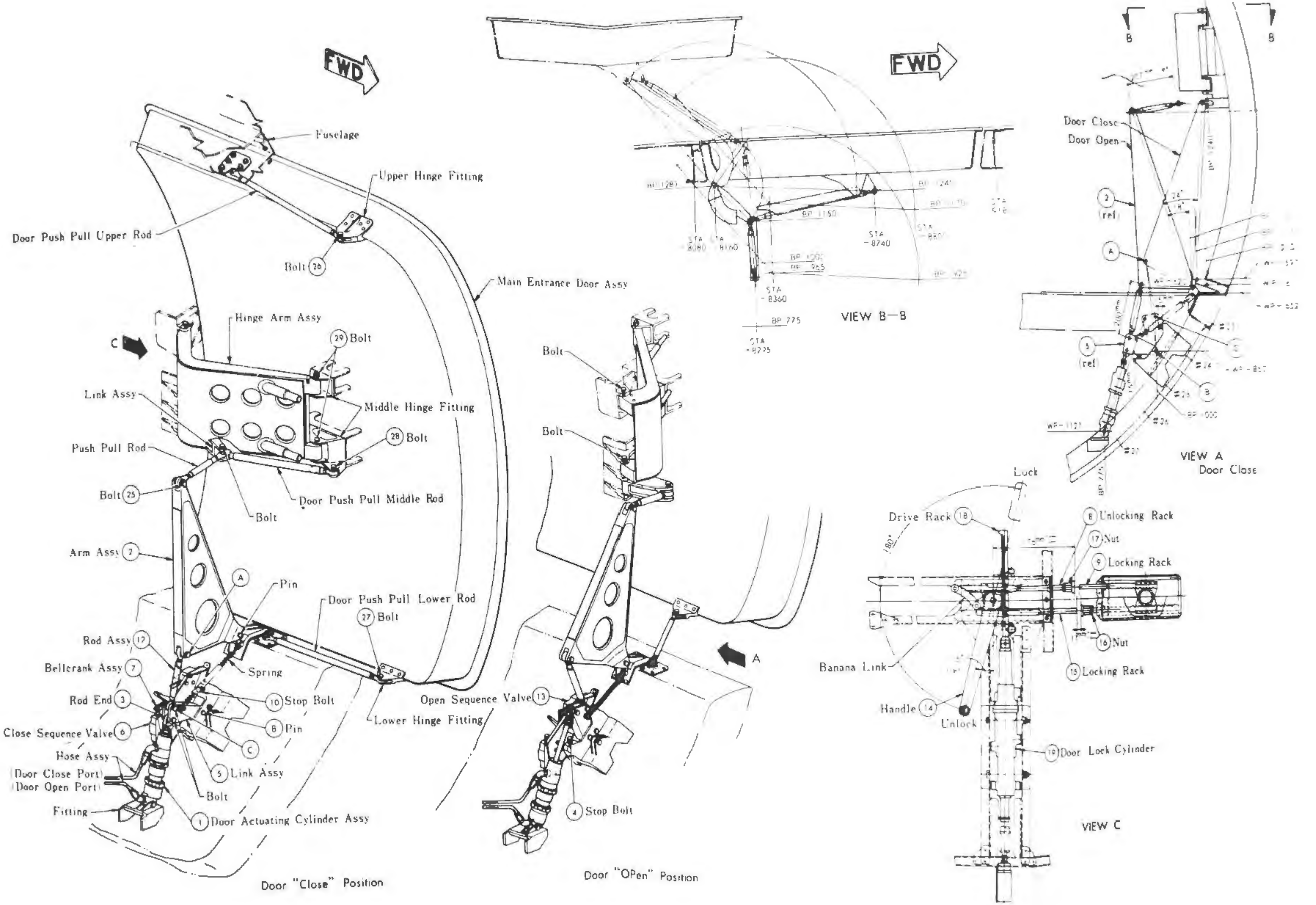


Locked Position

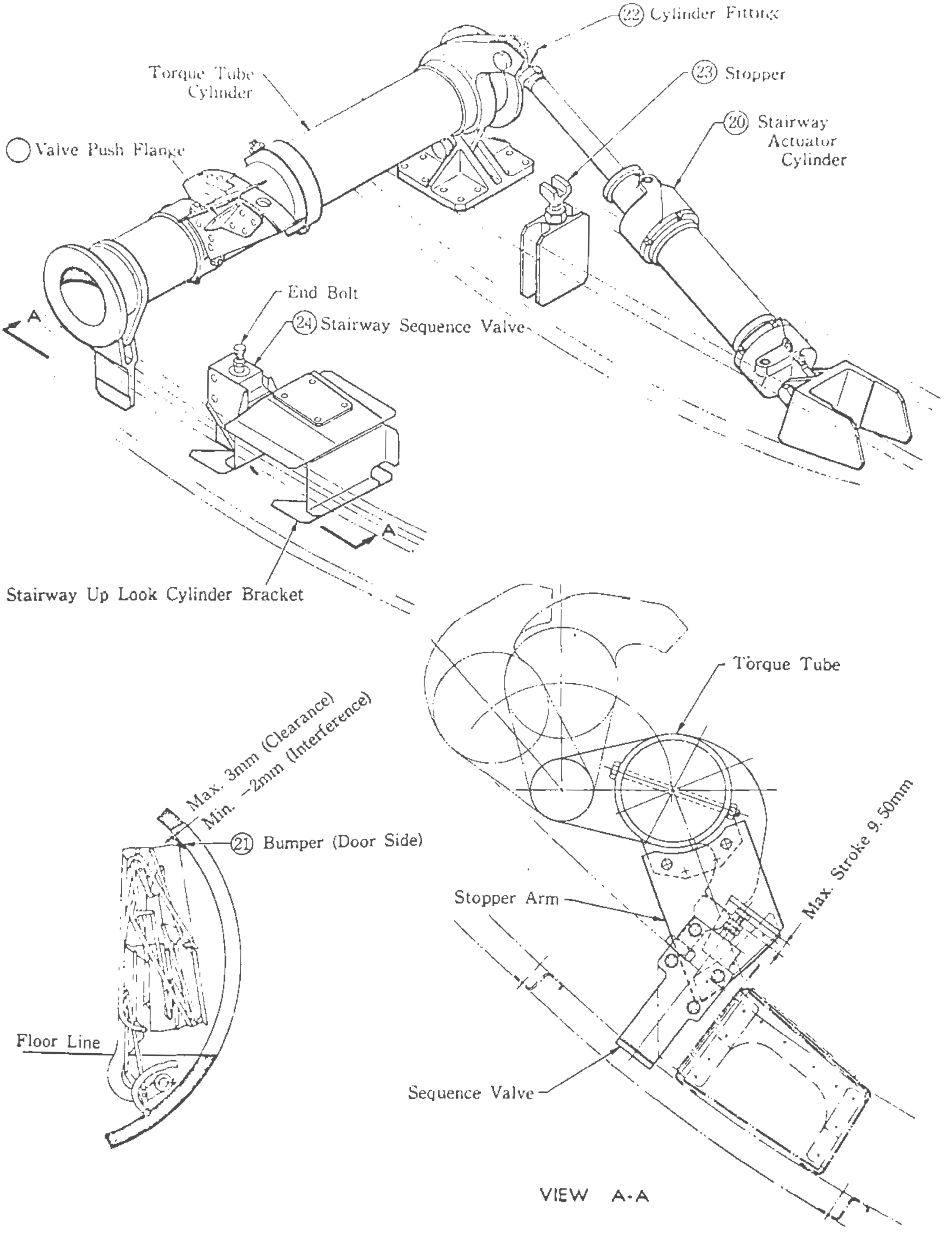
Unlocked Position

Door Locking Mechanism and Mechanical Lock

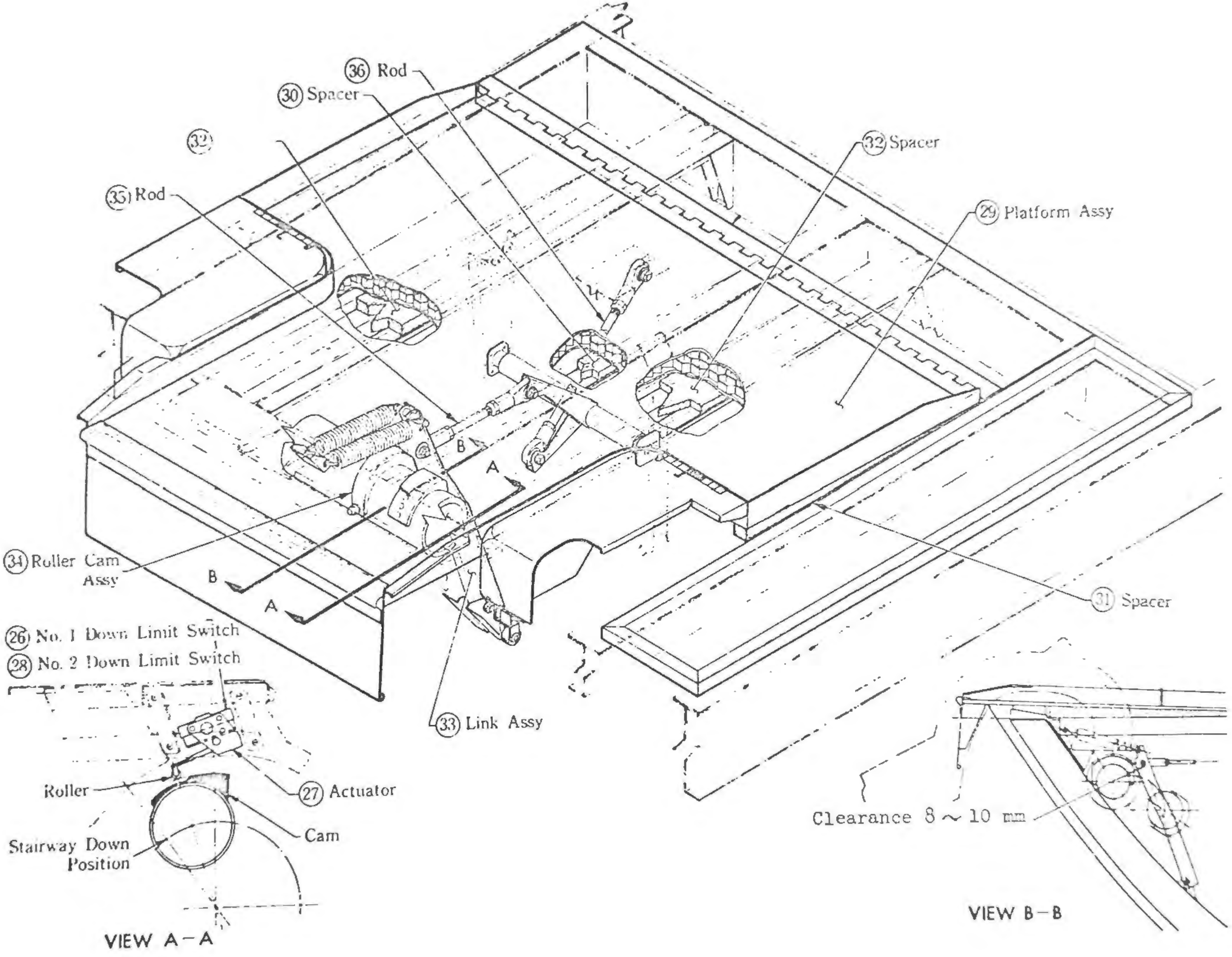
Figure 6–22



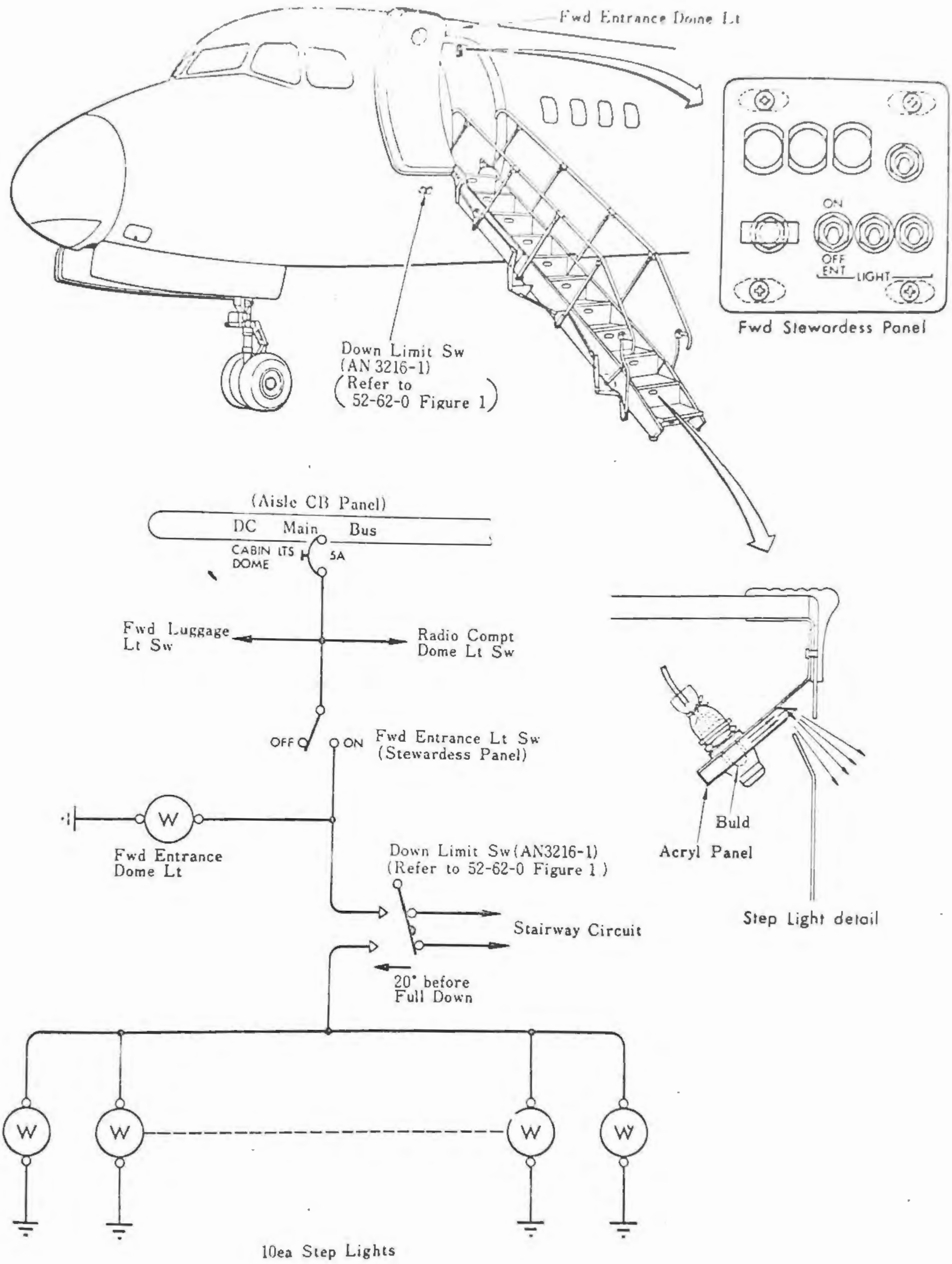
Door Opening Mechanism
Figure 6-23



Stairway Assy-Adjustment
Figure 6-23A

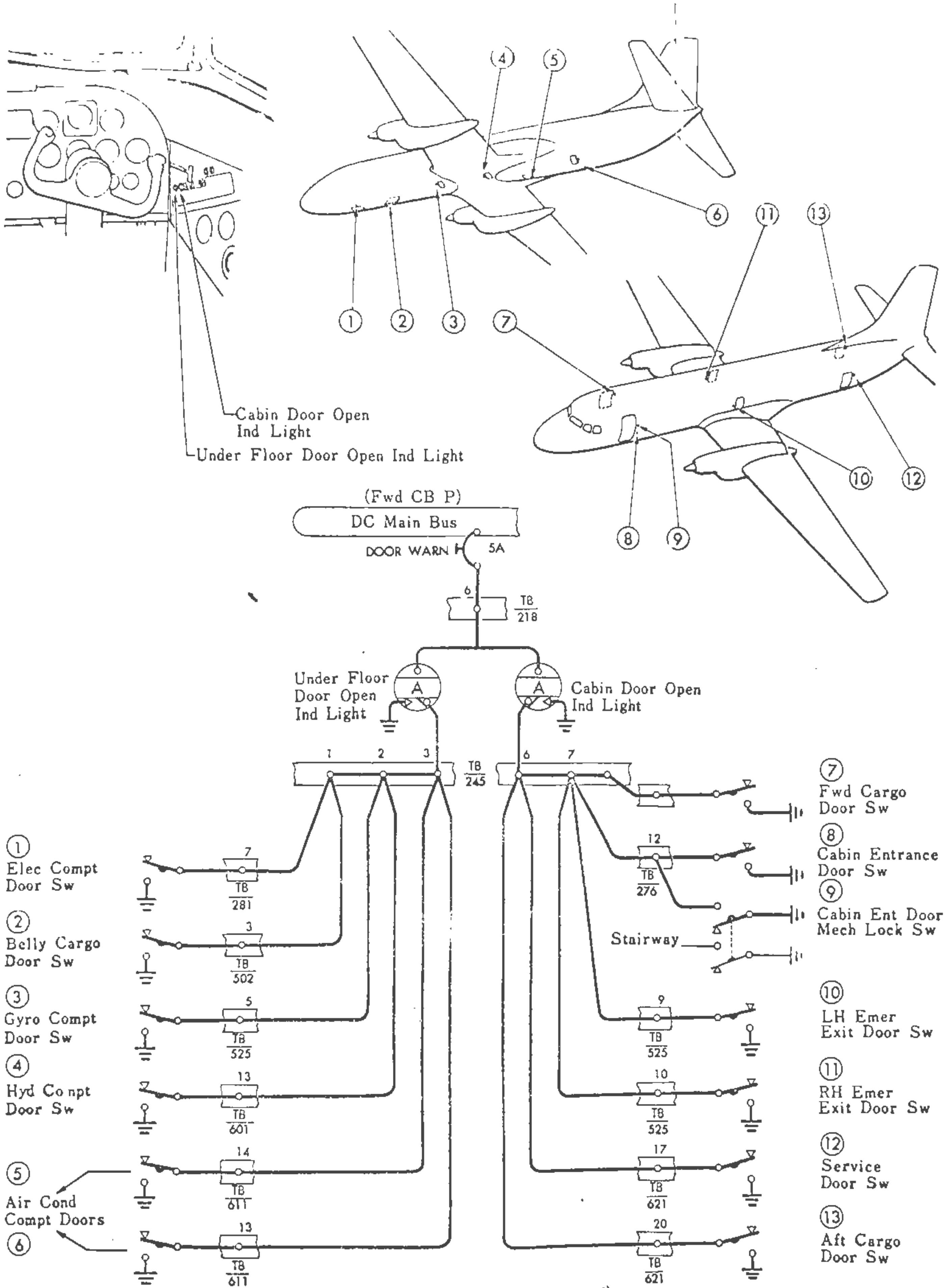


Platform Assy-Adjustment
Figure 6-23B



Stairway Lighting System

Figure 6–24



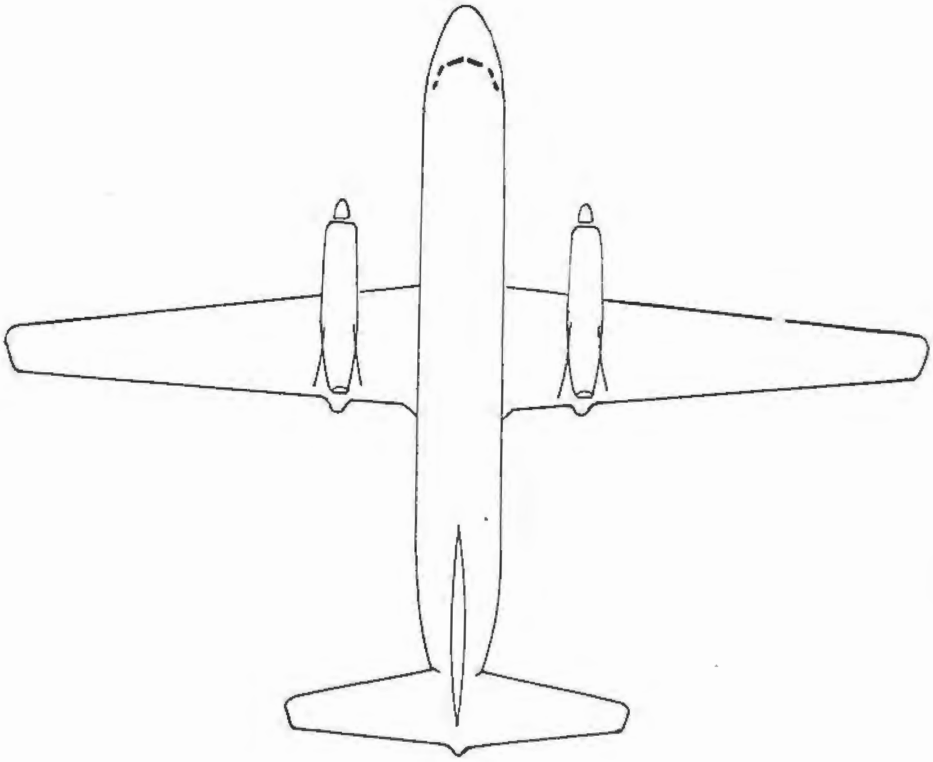
(All Doors closed and latched)

Door Warning System

Figure 6-25

THIS APPLIES TO
AIRCRAFT N214P
AND N218P ONLY.

YS—11A
TRAINING MANUAL
HYDRAULIC POWER



TRAINING SECTION, SERVICE DEPARTMENT
NIHON AEROPLANE MANUFACTURING CO., LTD.

N-212P only
N213P only

Hydraulic Power

CHAPTER SECTION	SUBJECT	PAGE
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29-10-16	START BY-PASS VALVE - DESCRIPTION AND OPERATION	1
	Start By-Pass Valve System - Operation Test	501
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[illegible]

Hydraulic Power System - Description and Operation

1. GENERAL DESCRIPTION

A. Type	Closed center system
B. Hydraulic Fluid	MIL-H-5606 (mineral (red) oil)
C. Pressure	3,000 psi (210.9 kg/cm^2)
D. Lines	Pressure lines - stainless steel tubing (MIL-T-6845) Return Lines - aluminum alloy tubing(5052-0)
E. Joint	"AN" standard type (flare type)
F. Total Quantity of Hydraulic Fluid	14.5 gal(5.5ℓ), including 6.22 gal (23.5ℓ) in the reservoir
G. Operating System	9 systems as follows

Non-essential	(1) Propeller Brake (3000 psi)
	(2) Ground Cooling (Approx. 1500 psi)
	(3) Stairway (Up 3000 psi Dn 1200 psi)
	(4) Windshield Wiper (3000 psi)
Essential	(5) Steering (3000 psi)
	(6) Landing Gear (3000 psi, Nose up 2000 psi)
	(7) Flap (2000 psi)
Brake	(8) Normal and Parking Brake (1200 & 800 psi)
	(9) Emergency Brake (2300 psi)

H. Working Temperature Range	-65°F (-54°C) to 160°F (71°C)
J. Pressure Source	Engine-driven hydraulic pump (VD) 2 each Motor-driven hydraulic pum (CD) 1 each

2. COMPOSITION

A. Main Hydraulic Power System

The main hydraulic power system consists of a pressure supply system including engine-driven pump, the reservoir and its pressurization system, the return line system, the depressurization valve and its control system.

NOTE

The emergency brake accumulator manual dump valve is also included.

B. Auxiliary Hydraulic Power System

In this system, the pressure supply system provided with the motor-driven pump and its electrical control system are included.

C. Hydraulic Indicating System

This system includes the hydraulic fluid quantity and pressure indicating system and the electrical system for the warning lights.

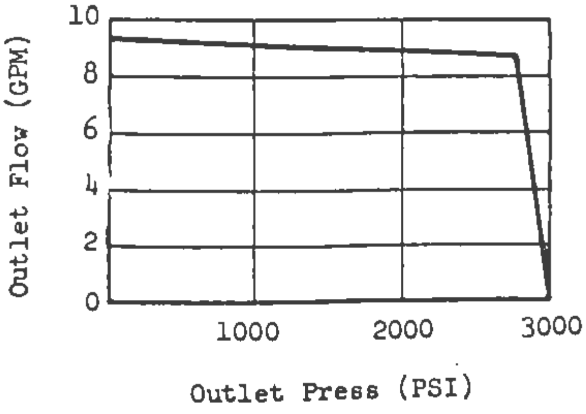
The hydraulic power system is grouped into the above-mentioned three systems. For further details, see their respective descriptions given under the head of "Description and Operation".

3. PERFORMANCE CHART

Reservoir	Total Space 7.66 gal (29.0ℓ) Oil Capacity 6.22 gal (23.5ℓ) (Refill 5.71 gal (21.6ℓ) Emer Hyd 2.06 gal (7.8ℓ) Air Space 1.45 gal (5.5ℓ) Pressurization 25 to 30 psi Abs. Air Relief 22 psi G

Engine-Driven Variable Delivery Pump

	Eng. rpm	Pump rpm	Variable Delivery Full Flow
T/O	15,000	3,980	8.65 GPM (32.7 LPM)
Cruise	14,000	3,720	8.10 GPM (30.6 LPM)
Landing	11,000	2,920	6.35 GPM (24.0 LPM)


Variable Delivery Pump 3980 rpm

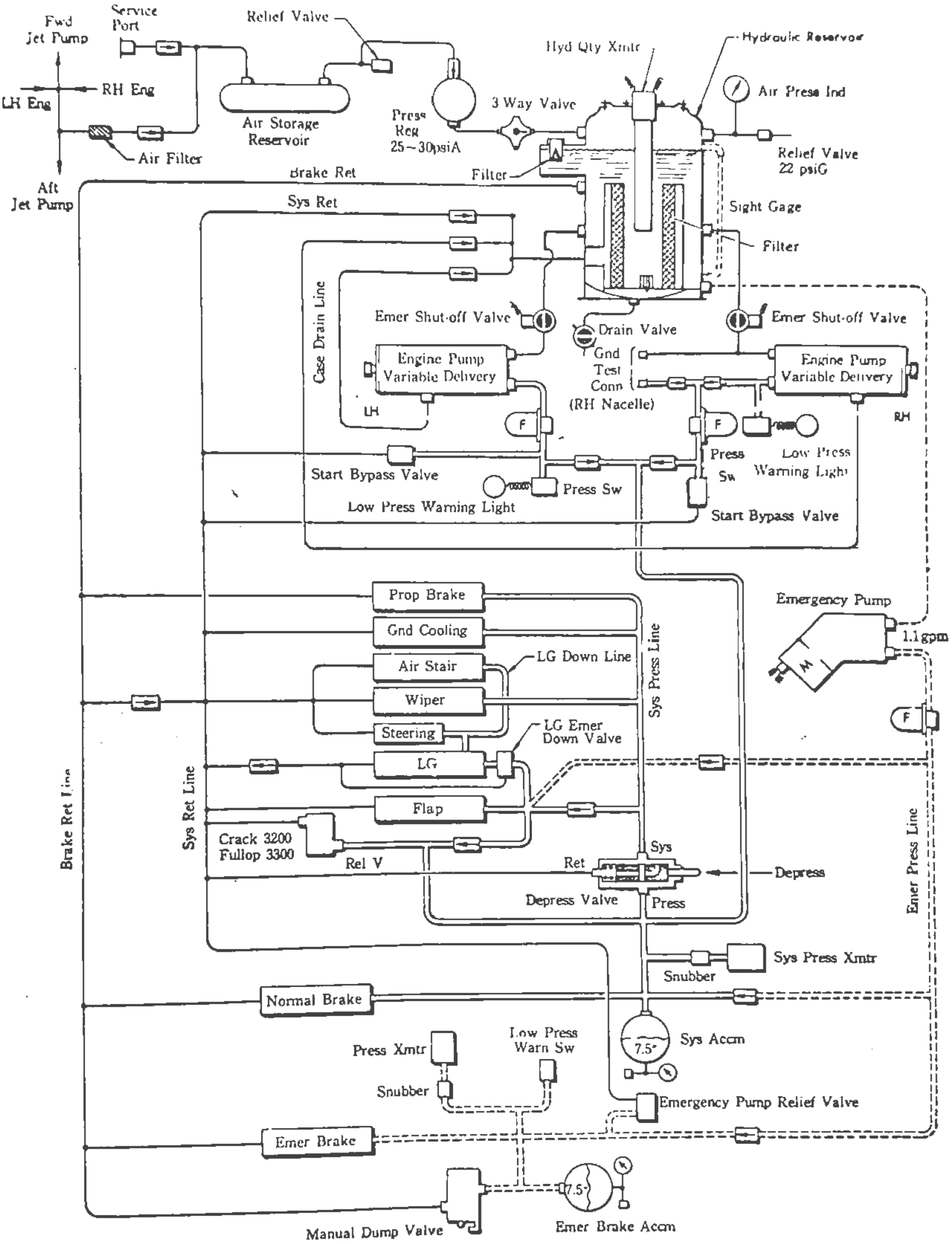


Fig 1 Hydraulic Power Schematic

Emergency Pump	Vickers, Motor Driven Fixed Displacement Type Output 1.1 GPM
System Pressure	
Variable Pump	0 Flow Press 2,900 to 3,000 psi
System Relief	Crack Over 3,160 psi Full Open 3,300 $\pm {}^{50}_{0}$ psi
Emer Pump Operating	Controlled by Emergency Pump Relief 3,000 ${}^{+50\text{ psi}}_{-0\text{ psi}}$
Flap Reducing	2,000 ± 50 psi
Accumulator	
7.5 in (Emer Brake Sys and Normal Sys)	198 cu in (0.86 gal (3.2ℓ))

4. TEFLON HOSE

The specification for the teflon hose changed to new specification in the hydraulic system.

	OLD	NEW
High Press Hose	MIL-H-38360A Amend 1	MIL-H-38360A
Medium Press Hose	MIL-H-25579C	MIL-H-25579B Amend 3

Engine-Driven Hydraulic Pump - Operational Test

1. GENERAL

Since the low pressure warning system is provided in each pump delivery line, no special operation test is required.
Ensure low pressure warning light for each pump on the co-pilot flight instrument panel goes out when engine running.

Main Hydraulic Power System - Description and Operation

1. GENERAL DESCRIPTION

The main hydraulic power system consists of a hydraulic pressure supply system to which hydraulic pressure is supplied by two engine-driven variable delivery hydraulic pump, the return line system to which hydraulic pressure returns from each operating system, the reservoir and its pressurization system.

The hydraulic fluid in the hydraulic reservoir in the hydraulic compartment is sent to the engine-driven hydraulic pump installed in the front of the right and left accessory gear boxes.

The delivery rate is regulated by the system pressure. And the fluid is supplied to 8 hydraulic actuating system.

NOTE

> The main hydraulic power system is not connected to the emergency brake system among the nine hydraulic system.

The worked hydraulic fluid flows back into the hydraulic reservoir in the hydraulic compartment after passing through the system return line and/or brake return line. The hydraulic reservoir has been pressurized with the engine bleed air.

2. FEATURES

A. The variable delivery pump is driven by the engine, and forms the hydraulic power source for the normal systems.

B. While the hydraulic power is not used during flight, the system pressure in the down stream side of the de-pressurization valve is reduced by means of the de-pressurization valve, and the delivery of the variable delivery pump is reduced to null whereas the pressure is maintained at 3,000 psi.

C. The 7.5-inch spherical accumulator is used. (Pressure remains in the accumulator even when hydraulic pressure is being depressed.)

D. Some 65 percent of the hydraulic fluid in the reservoir may be used for the main hydraulic system and the remaining 35 percent of the hydraulic fluid is for the emergency hydraulic system.

E. The return line system is divided into two. That is, the brake return line is separated from the system return line. The system return line passes through the check valve, reaching the filter in the reservoir.

The brake system, on the other hand, passes neither through the check valve nor through the filter in the reservoir. This aims at avoiding giving back pressure to the brake system (for efficient return of the brake) and also at preventing the system return surge pressure from being added to the brake.

F. The reservoir is located at a lower place than the engine-driven hydraulic pump; and accordingly to push up the hydraulic fluid from the reservoir, the engine bleed air is added to the reservoir

G. The hydraulic fluid can be supplied to the reservoir from the cabin even while the aircraft is flying.

3. COMPOSITION (See 29-00-0 Figures 1 and 2)

The main hydraulic power system consists of the following components and lines. For the details of each of these components, see their respective description.

A. Engine-Driven Hydraulic Pump

B. Hydraulic Reservoir

C. Hydraulic System Accumulator

D. Hydraulic Depressurization Valve

E. Hydraulic System Relief Valve

F. Main Hydraulic Filter

G. Emergency Hydraulic Shut-off Valve

H. Hydraulic Ground Test Connection

J. Air Storage Reservoir

K. Hydraulic Reservoir Air Pressure Regulator

L. Hydraulic Reservoir Air Pressure Relief Valve

M. Hydraulic Reservoir Air Manual 3-Way Valve

N. Hydraulic Reservoir Air Pressure Gage

P. Emergency Accumulator Manual Dump Valve

Q. Start By-Pass Valve

R. Lines and Joints

Generally, the high pressure lines and other lines in the nacelle are fabricated of stainless steel, while the return line and low pressure line fabricated of aluminum alloy. Moreover, wire-braided hose is used where the suction line is connected directly to the engine-driven pump.

The joint to be employed is, generally, of the "AN" standard flare type. The low pressure lines, in the flap well, however, has been provided with a flexible joint at two places because the line is large in diameter and is liable to an influence of the deflection of the wing.

(4) Selector Relay	Circuit Breaker	"OFF"
(5) Ignition	Circuit Breaker (4 ea.)	"OFF"
(6) Hydraulic By-Pass	Circuit Breaker	"ON"
(7) Prop. Brake		"OFF"
(8) Starter Master	Switch	"START" or "BLOW OUT"
(9) Engine Selector	Switch	"No. 1 or No. 2"

NOTE

Do not enter into the propeller rotating disc, while following the above procedures, because the propeller may turn unexpectedly.

C. Rotate the propeller for five minutes by hand.

D. Motor the engine for 30 seconds in accordance with the "BLOW OUT" procedures.

Depressurization Valve Control System - Adjustment

1. GENERAL

The following description covers the whole depressurization valve control system; however, when only the depressurization valve is replaced, make the adjustment by following the paragraphs from F to H and L.

2. ADJUSTMENT

A. Loosen the adjusting plate (1). (Detail D.)

B. Set the control lever (2) to "NORMAL".

C. Adjust the length of the rod (4) so the indication bracket and the rigging mark (3) may agree with each other. (Details A and C.)

D. Remove the rod from the depressurization valve and insert the rig pin (7) in the pulley (6). (View E.)

E. Adjust the cables to 29 ± 4 lbs. (13 ± 2 kg) tension by means of the turnbuckles in the electric compartment and the gyro compartment.

NOTE

The above-mentioned cable tension 29 ± 4 lbs. (13 ± 2 kg) is at 70°F (21°C). With 1°F variation of temperature, the cable tension also varies by 0.4 lb.

F. Push the depressurization valve arm (8) by hand till it stops. (In this state, the valve spool is in contact with the inner stop for the NORMAL position.)

NOTE

Since no visual confirmation is possible, pay much attention to a response from the stopper.

G. Determine the length (A) of the rod (5) while maintaining the state described in Paragraph F; and install the rod to the pulley (6).

H. Pull out the rig pin (7) and force the control lever (2) down toward the "DEPRESS" position.

NOTE

When the control lever is moved from the NORMAL position to the DEPRESS position, the valve spool stroke is 15/32 inches (12 mm). (See 29-10-5, Figure 1.)

(2) Put the depress valve control lever in "NORMAL" position, maintain the pressure of normal systems at 3,000 psi, then cut the flow from the stand. Measure the normal systems pressure 4 minutes after the flow is cut, which shall be above 2,000 psi.

(3) Set the depress valve control lever to "DEPRESS" position, and measure the normal system pressure, after maintaining the system pressure at 3,000 psi for half an hour. The pressure shall not be less than 2,000 psi.

(4) Put the depress control lever in "DEPRESS" position, and the parking brake in "ON", and then bring the normal and emergency system pressure up to 3,000 psi and leave it for 1 hour and 30 minutes. Then the both pressures must be measured, the normal pressure shall be above 1,000 psi, and the measured emergency pressure shall be above 2,000 psi.

Start by-Pass Valve - Description and Operation

1. GENERAL (See Figure 1)

The start by-pass valve is an operating shut-off valve installed in the delivery line of the engine driven pump, up stream of the check valve, and makes engine start easier by reducing the load upon the pump and thereby reducing the load upon the starter.

When the engine selector switch is selected at "No. 1", the valve in the pump delivery line on the No. 1 engine is opened and the pump delivery is returned directly to the reservoir. When it is selected at "OFF" or "No. 2", the valve on the No. 1 system is closed and the hydraulic fluid flows into the main hydraulic accumulator to raise the accumulator pressure. When the selector switch is selected at "No. 2", the valve on the No. 2 system is opened. In order to confirm the open or close position of the valve, position indicator is provided on the valve.

2. OPERATION

The start by-pass valve is controlled by the engine starting circuit, i.e., in normal condition the close position of the valve is connected via the nromal close contact of the hydraulic by-pass relay through 5A circuit breaker, and when the engine selector switch is selected at No. 1 or No. 2 and the start master switch is put in "START" or "BLOW OUT" position, the No. 1 or No. 2 hydraulic by-pass relay respectively is magnetized and the electrical power is supplied to the valve to open the valve and by-pass the hydraulic fluid.

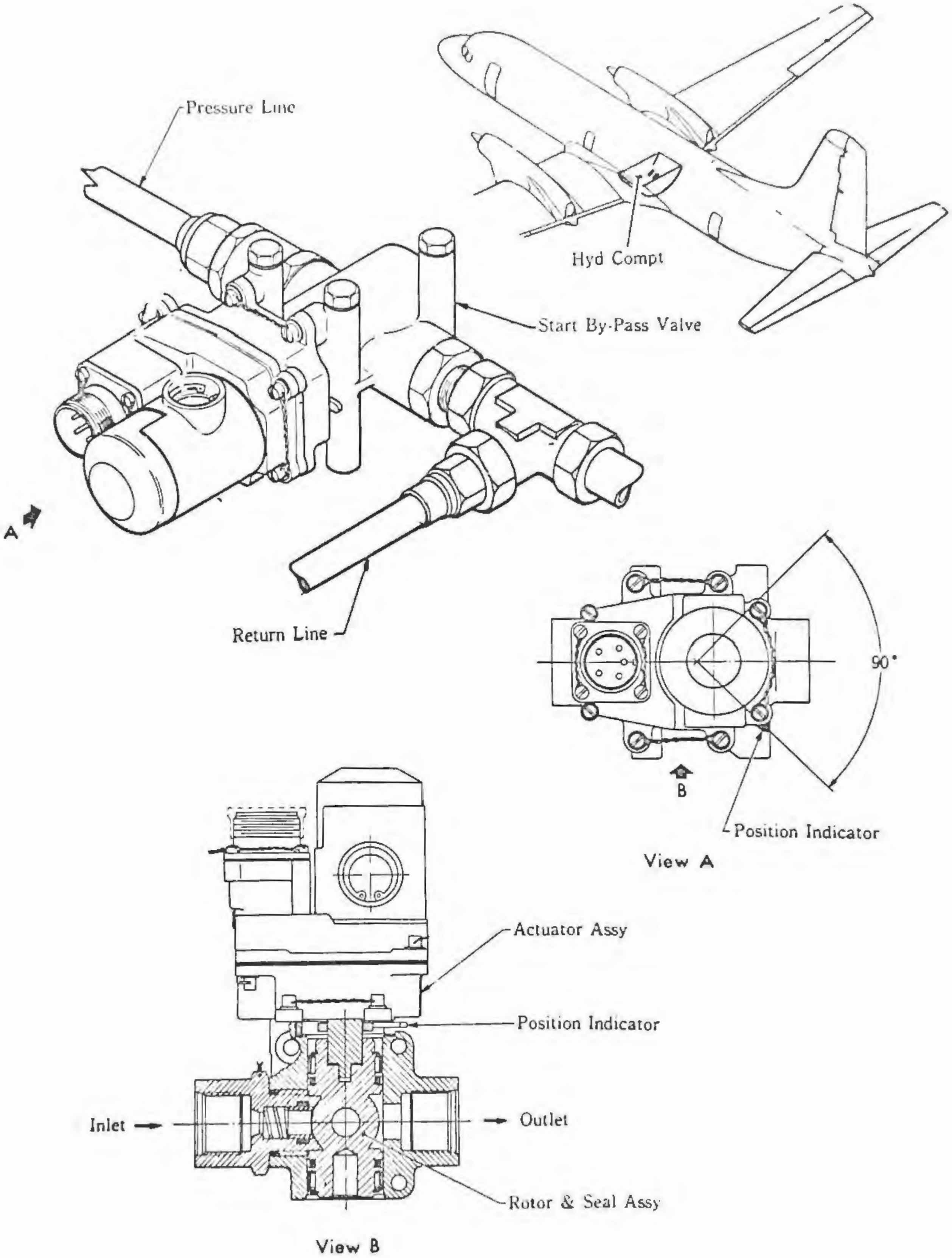
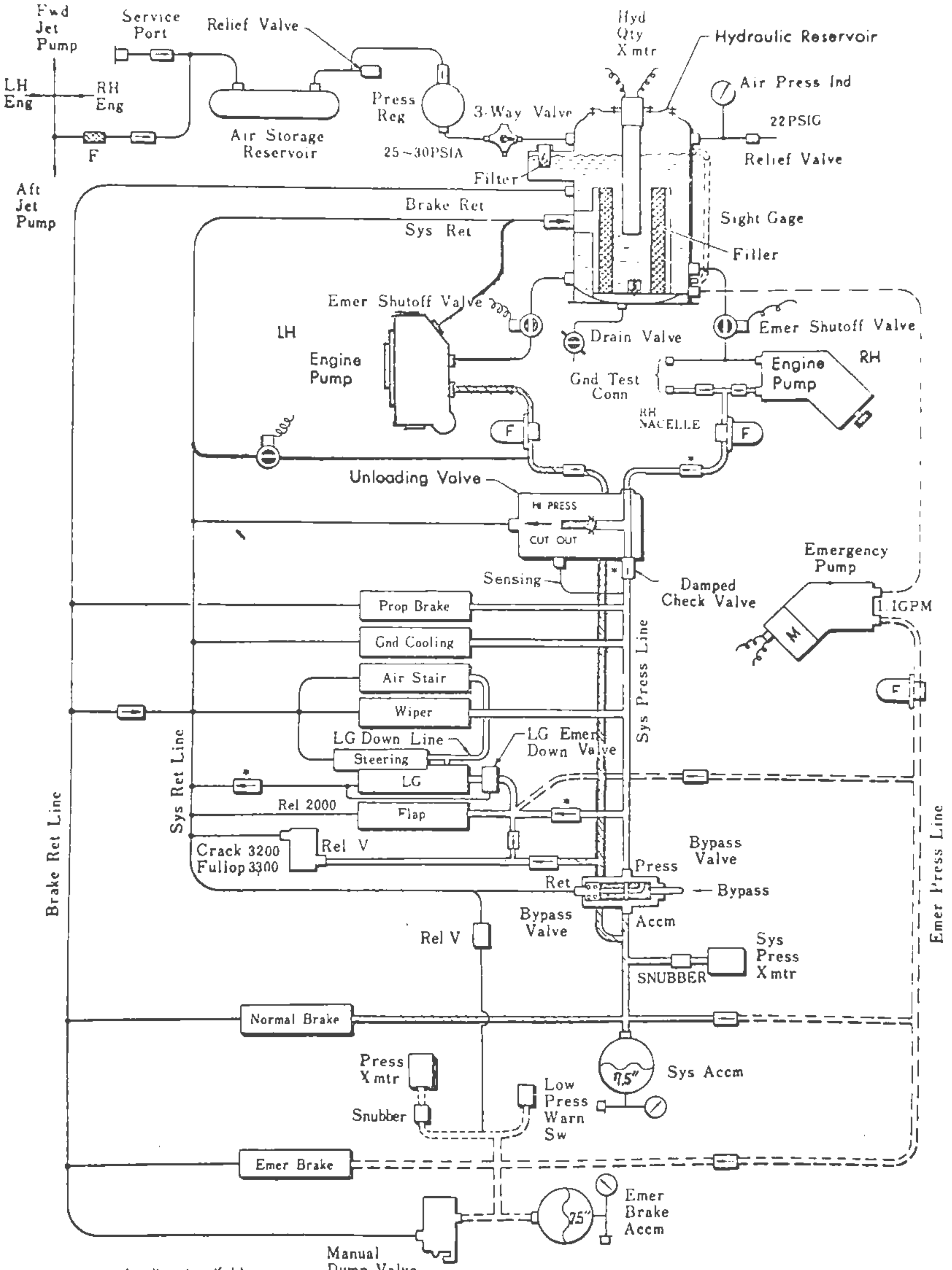


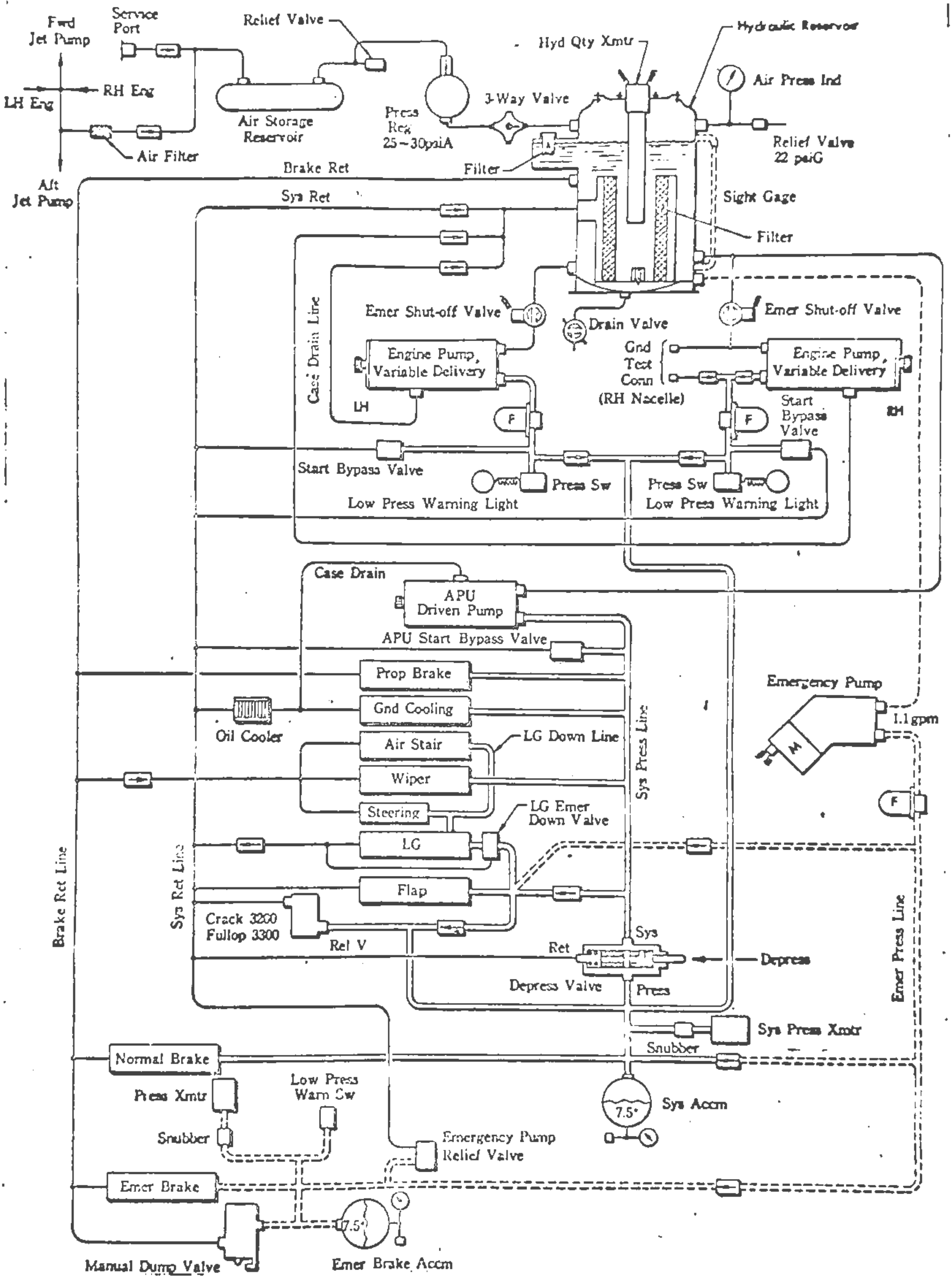
Fig 1 Start By-Pass Valve



*: Installed on Unloading Manifold

Hydraulic Power Schematic

Figure 6–1



Hydraulic Power Schematic

Figure 2

1. Check Valve
2. Restrictor
3. Door Actuating Cylinder
4. Door Lock Cylinder
5. Door Close Sequence Valve
6. Door Open Sequence Valve
7. Stair Sequence Valve
8. Stairway Actuating Cylinder
9. Door Relief Valve
10. Stairway Control Valve
11. Pressure Reducing and Relief Valve
12. N.L.G. Actuating Cylinder
13. N.L.G. Up Lock Release Cylinder
14. Nose Wheel Steering Actuating Cylinder
15. Nose Wheel Steering Control Valve
16. Hydraulic Filter
17. Back Pressure Valve
18. Wiper Window Unit
19. Wiper Control Unit
20. Wiper Speed Control Valve
21. Propeller Brake
22. Engine Driven Pump, Variable Delivery
23. Emergency Shut-off Valve
24. M.L.G. Up Lock Release Cylinder
25. M.L.G. By-Pass Valve
26. M.L.G. Actuating Cylinder
27. Swivel Joint
28. Brake Lock-out Cylinder
29. Bleeder Valve
30. Shuttle Valve
31. Emergency Hydro Pump
32. Exterior Drain
33. L/G Control Valve
34. Anti-Skid Control Valve
35. Normal and Parking Brake Valve
36. Flap Control Valve
37. Depressurization Valve
38. Emergency Brake Valve
39. Pressure Switch
40. Propeller Brake Control Valve
41. Emergency L/G Down Valve
42. System Relief Valve
43. Flow Regulator
44. Flap Torque Motor
45. Seal Drain
46. Start By-Pass Valve
47. System Accumulator
48. Emergency Accumulator
49. Controllable Check Valve
50. Pressure Guage
51. Air Charging Inlet
52. Swing Check Valve
53. Air Filter
54. Relief Valve
55. Drain Plug
56. Air Storage Reservoir
57. Pressure Regulator, Air
58. 3 Way Valve, Reservoir Air Depressurization
59. Reservoir
60. Fluid Quantity Transmitter
61. Reservoir Relief Valve
62. Drain Valve
63. Anti-Skid Pressure Modulator
64 Thermal Relief Valve
65. Snubber
66. Pressure Transmitter
67. Ground Cooling Fan Shut-off Valve
68. Priority Valve
69. Torque Motor Ground Cooling Fan
70. Test Stand Connectors

Hydraulic System Schematic Diagram (YS-11A-200)

4. OPERATION (See 29-00-0 Figure 1)

A. Operation of the Reservoir Pressurizing Air System.

The bleed air coming from the engine is reserved in the air storage reservoir at about 30 to 77 psig. and reduced to 25 to 30 psi of absolute pressure by the regulator, finally going into the hydraulic reservoir.

As the level of the hydraulic fluid in the hydraulic reservoir goes down, the air is filled to the reservoir to maintain the same pressure as the initial one. On the contrary, as the fluid level goes up suddenly, the air pressure in the reservoir is increased because the relief valve of the regulator is not enough to let the air pressure out rapidly from the reservoir.

When the air pressure increases 22 psi more than the cabin pressure, the over air pressure is let out from the relief valve. (The inner pressure of the fuselage is about 14.7 to 10.8 psi; and therefore it is equal to 36.7 to 32.8 psi of absolute pressure.)

The suction port of the engine-driven hydraulic pump is located some 44 inches high over the outlet of the hydraulic reservoir suction line. This air pressure provides the reservoir with the same effect as though the reservoir, contrarily, were located 280 inches higher than the engine pump. This effect grows the greater when the aircraft is cruising the higher altitude.

B. Operation of the Main Hydraulic Power System (Depress Lever "NORMAL")

The hydraulic fluid delivered by the pumps driven by both engines, flows into the main hydraulic accumulators directly through respective check valve, and the deliveries of the pumps are controlled by the accumulator pressures. These check valves are the isolation check valves to prevent the loss of the hydraulic pressure into the pipings of the other side on which the pressure is lost due to engine quiet or failure of pump. In between the check valve and the pump, the pressure switcher is provided to light the cockpit warning light when the pump delivery pressure does not rise properly due to pump failure.

In normal condition, the pump delivery line is connected to the systems, and if none of the systems is being used, the system pressure reaches 3000 psi, and the delivery is reduced to null. If any of the systems is put in use, the system pressure is reduced, to which the compensator of the pump responds and starts delivery. While systems such as the ground cooling fan, flap, and wipers which require constant flow steadily, are being operated, the system is maintained at the pressure with which the pump delivery is equal to the flow required for the system operation. While starting the engine, in order to reduce the load upon the starter, the pump delivery is directly returned to the reservoir, by means of the motor driven start by-pass valve located upstream of the check valve in the pump delivery line, which works in conjunction with the engine selector switch.

In the ground cooling system, the priority valve set at 2,000 psi is provided, and the system does not operate when the system pressure is below this value.

When the pump delivery pressure becomes abnormally high due to the failure of the variable pump, the relief valve works to withhold the system pressure at 3,300 $^{+50}_{-0}$ psi.

NOTE

The engine driven pump does not supply pressure to the emergency brake system.

C. Operation of the Main Hydraulic Power System (Depress Lever "DEPRESS")

When the depress valve control lever on the R.H. console in the cockpit is pushed down to the "Depress." position, the pressure and delivery of the engine-driven pump become 3,000 psi and null, respectively and the system pressure in the down stream side of the depressurization valve is by-passed to return and is decreased.

Even in this condition, the essential two systems of landing gear and flap (including the nose wheel steering and the stairway fed by the L/G down line), and the two systems for the brake, may be supplied pressure from the electrically driven emergency pump.

In case the motor-driven pump inoperative, only the accumulator of the main and brake system serves as the pressure source and therefore other than the normal and emergency brake systems can not work because of no supply of pressure.

5. CAUTIONS ON MAINTENANCE

A. On Overcharge of the Hydraulic Fluid.

The hydraulic fluid may sometime be charged into the reservoir by the use of the ground test stand after performing the maintenance of the hydraulically-operated system, for example the removal of air by bleeding from the brakes system by using the test stand.

In this case, however, a full care shall be taken. Because, should the reservoir be overcharged, the 22-psi relief valve would not be capable of relieving the increasing pressure caused by the overcharged hydraulic fluid, possibly resulting in the damaged reservoir and moreover in the reverse flow of the fluid into the air pressure regulator and consequently the damaged regulator. Accordingly, when charging the hydraulic fluid to the reservoir, remember to keep open the service port.

B. On Position of the Reservoir Air Manual 3-Way Valve at Refilling the Fluid.

Close the reservoir air manual 3-way valve located at the upper part of the left, rear side of the reservoir, and the air pressure in the air storage reservoir can be secured. This seems to be advantageous. But, because it is not designed to return back open position by the spring, the valve remains closed if you forget to open it. So, before you close the port for the maintenance of the hydraulic systems after completing the maintenance work, never forget to open the valve. Namely, remember to make certain that the manual 3-way valve is properly in the "NORMAL" position.

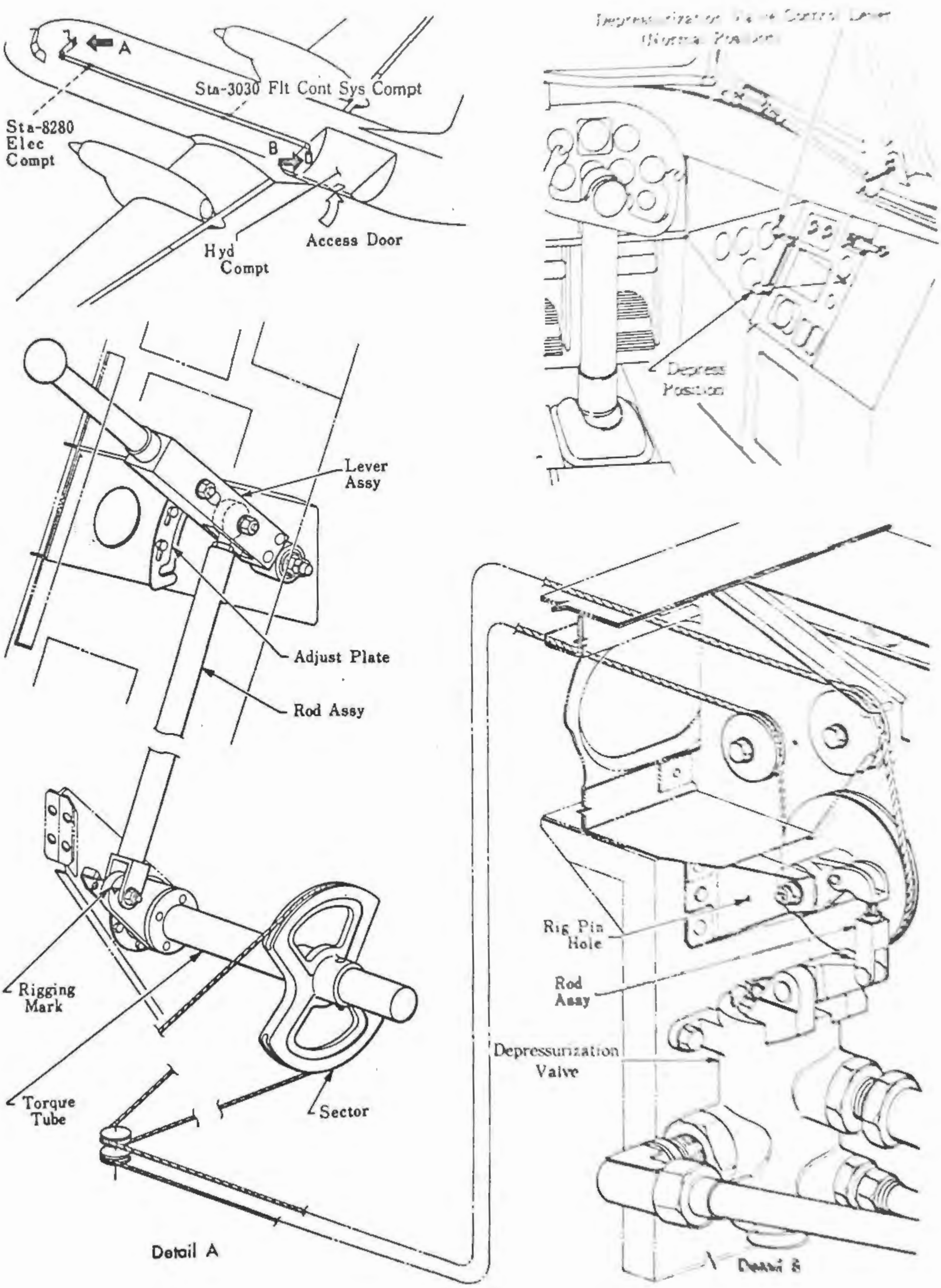


Fig 1 Depressurization Valve Control

C. On the Air in the Suction Line.

In the case there is a doubt that the air entered the suction line when the suction line was disconnected or when the hydraulic fluid in the reservoir decreased below the suction port, be sure to perform air bleeding in accordance with the procedure given in Page 301, 29-10-0.

Also remember to make a check on the pressure of the pressurized air in the reservoir after bleeding; and if the pressure is low below the specified value, refill it, before starting the engine.

NOTE

1. When disconnecting the suction line, you had better keep the emergency shut-off handle pulled.
2. Bleed air from the variable delivery type pump sufficiently, otherwise, abnormal noises or vibrations take place, damaging the pump.

D. When the Hydraulic Test Stand is Employed for Performing Various Operations.

In this case, the fluid in the reservoir is liable to go down toward the test stand. (The procedure in Paragraph C will become of necessity.) Accordingly, during the use of the test stand, be sure to keep the reservoir of the test stand closed.

E. Initial Pressure of the Air Storage Reservoir.

When performing hydraulic operation by the use of the hydraulic test stand, or immediately before starting the first engine, never forget to replenish 50 to 100 psi of air to the air storage reservoir.

Engine-Driven Hydraulic Pump Line - Air Bleeding

1. GENERAL

In the case it may well be considered that the air entered the pump line, on account of maintenance, the hydraulic pressure was drawn out from the hydraulic reservoir or when any part of the suction system, such as the pump and others, was replaced, remove the air by bleeding from the pump line in accordance with the following procedure.

2. PREPARATORY WORK

A. Fill the hydraulic fluid to the hydraulic reservoir up to the mark "FULL" of the sight gage of the reservoir.

B. Replenish the specified air pressure to the air storage reservoir.

C. Make certain that the hydraulic reservoir air pressure gage is indicating 10 to 15 psi.

3. SUCTION LINE AIR BLEEDING

A. Loosen the pump suction line by loosening the nut at the joint on the pump.

B. Apply the waste and let it stand till no bubble is recognized in the leaking hydraulic fluid.

C. After ascertaining that no air comes out from the suction line, tighten the "B" nut. Wipe off fluid in the vicinity.

D. Supply the hydraulic fluid into the hydraulic reservoir.

E. Check the air storage reservoir to see if the specified air pressure is in it.

4. OUTLET LINE AIR BLEEDING

A. Raise the accumulator pressure to 3,000 psi, with the emergency hydraulic pump, so that no air will enter the accumulator.

B. Open the by-pass valve in accordance with the following procedures.

Connect the external power source to the aircraft, and set the circuit breakers and switches as follows;

(1) Battery	Switch	"EXT."
(2) Engine Start	Circuit Breaker	"ON"
(3) Main Bus Vol.	Circuit Breaker	"ON"

J. Install the adjusting plate (1) while holding the control lever lightly

K. Tighten all the lock nuts and put the safety wires to the turnbuckles.

L. Make certain of the cable tension again; and then ascertain by moving the control lever 2 to 3 items that there is no abnormality with it.

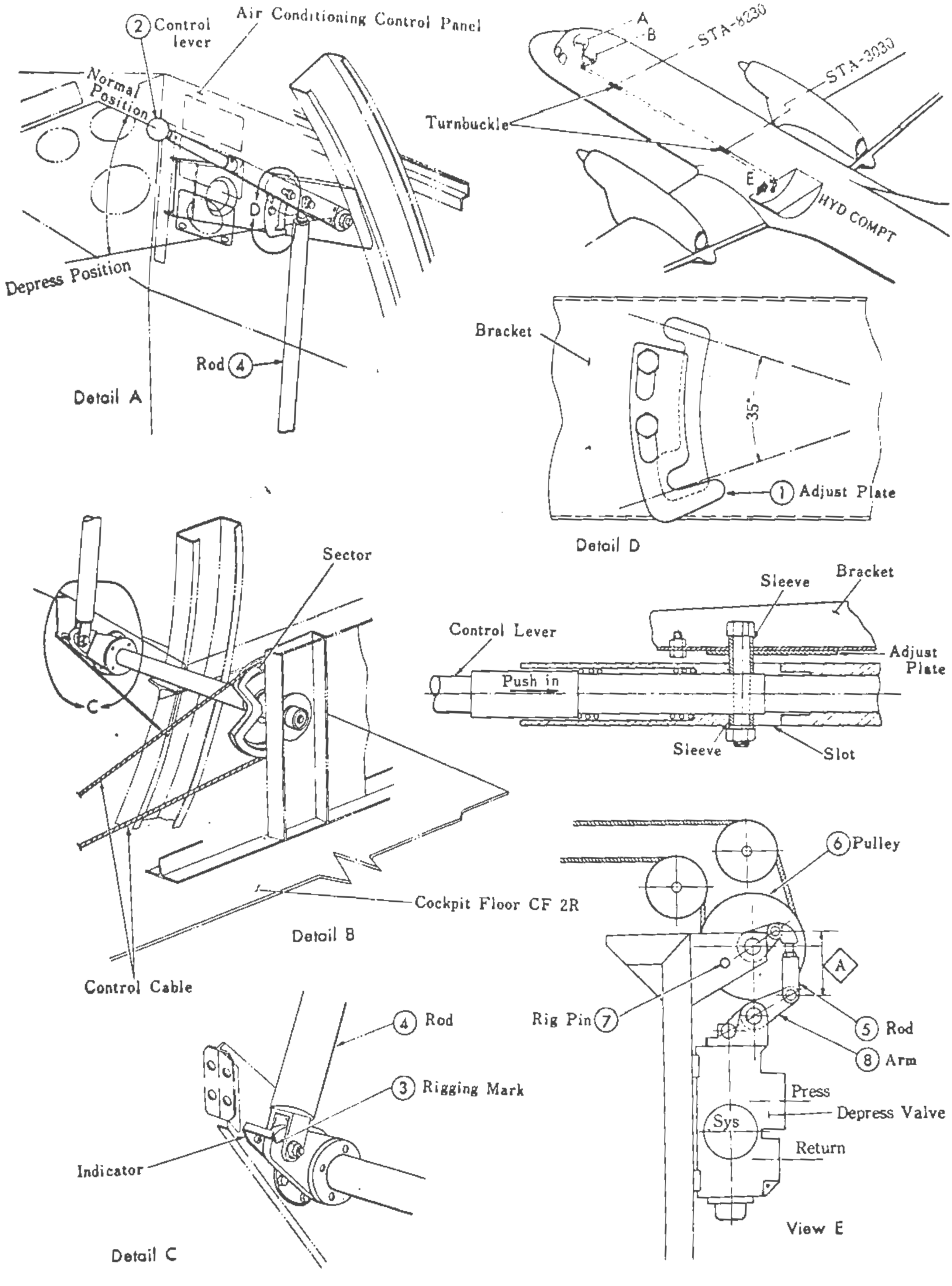


Fig 1 Depressurization Valve Control System-Rigging

Hydraulic Power System - Operational Test

1. GENERAL

This operational test involves the ascertainment of depressurization valve operation and their control, and also of the presence of the whole hydraulic system, internal leakage.

2. PREPARATORY WORK

A. Connect the hydraulic test stand to the aircraft.

B. Connect the external electric power to the aircraft.

C. Turn the inverter switch "ON" and close the circuit breaker of "INST. TRANS. No. 2."

D. Set the selector switch of the hydraulic pressure gage of the aircraft to the "NORMAL" position.

E. Supply the hydraulic fluid into the hydraulic reservoir.

F. Supply the air storage reservoir with the air pressure.

G. Make certain that the manual 3-way valve is "NORMAL" position.

H. Supply the accumulator (system and emergency brake accumulator) and the anti-skid modulator with the specified pressure of air.

J. Prepare for a stop watch or a wrist watch having a center second pointer.

K. Set the depressurization valve control lever to "NORMAL."

CAUTION

In this test, be sure to use the reservoir of the aircraft. Do not use the hydraulic test stand reservoir.

3. TEST

A. Depressurization Valve Operation Test.

(1) Set the hydraulic test stand pressure to 3,000 psi, and send hydraulic pressure to the aircraft.

(2) Make certain by moving the depressurization control lever 2 or 3 times that there is no abnormal on the control lever.

B. Internal Leakage Test of the Whole Hydraulic System.

(1) Set the pressure of the hydraulic test stand at 3,000 psi, and feed the hydraulic pressure to the aircraft.

Engine-Driven Hydraulic Pump - Description and Operation

1. GENERAL (See Figure 1)

The pump produced by Vickers Limited is of the axial plunger type with nine cylinders and the delivery is varied by changing the swashplate angle and thereby the plunger stroke.

The pump speed is 0.265, times the engine speed and the pump delivery rate is 0.520 cu. in./rev. The pump is installed on the right front face of the engine gear box, and the fluid is circulated from the case drain to the reservoir to ensure cooling and lubrication while the pump is rotating. One port of the two seal drains, located on the lower face is left open.

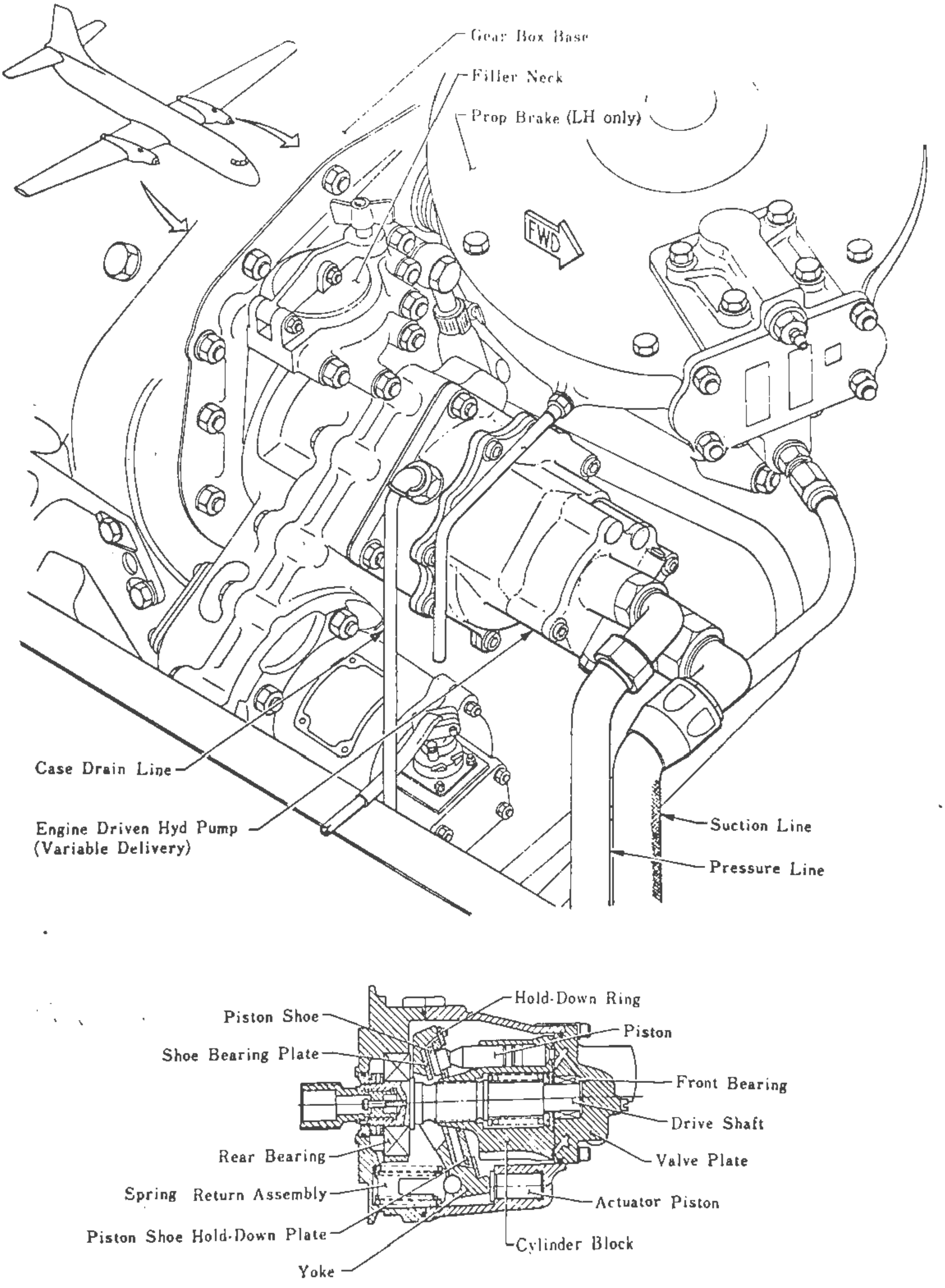


Fig 1 Engine Driven Hydraulic Pump (Variable Delivery)

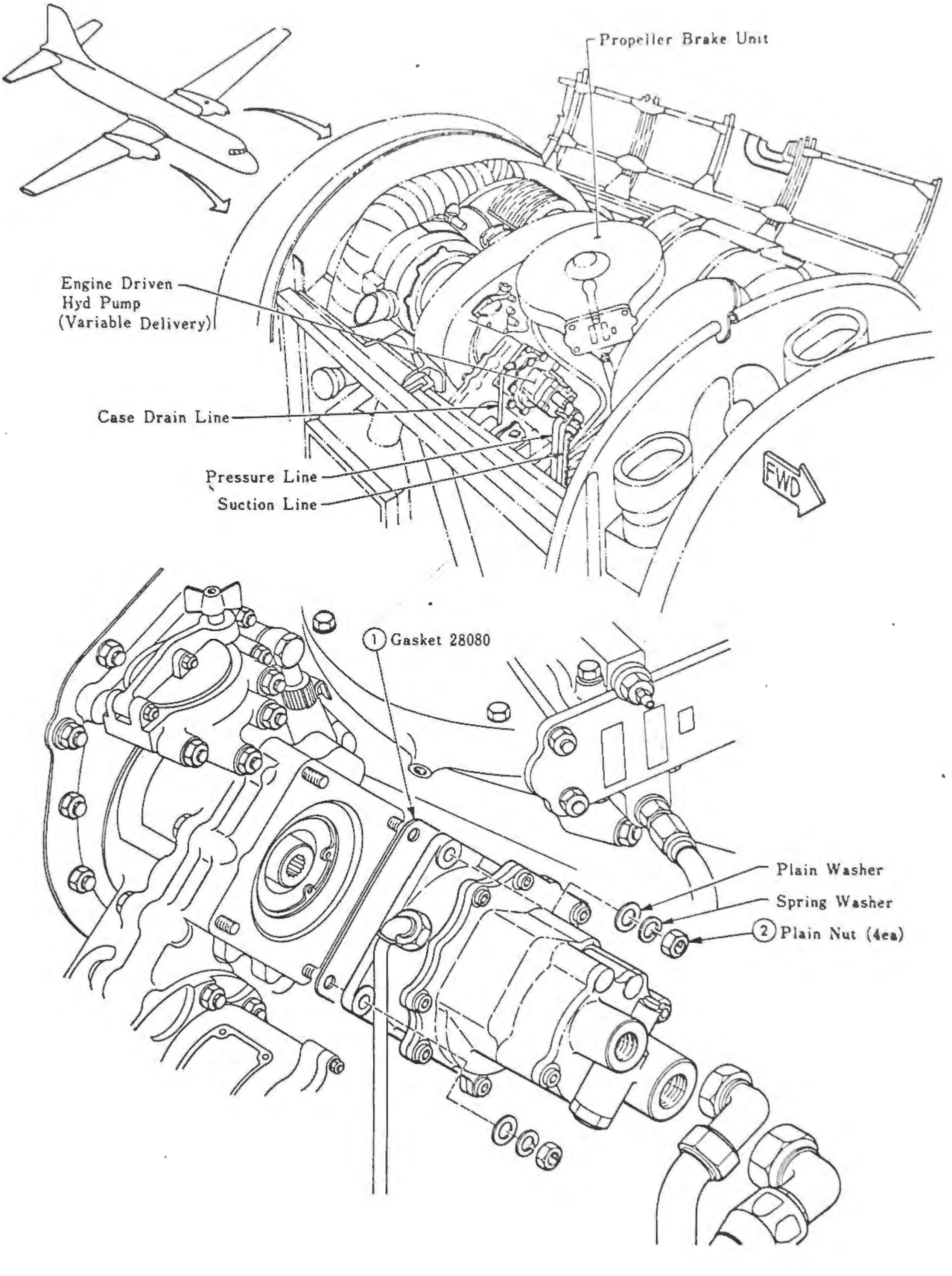


Fig 2 Engine Driven Hydraulic Pump (Variable Delivery) Remove Installation

Hydraulic Depressurization Valve - Description and Operation

1. GENERAL (See Figure 1)

The hydraulic depressurization valve, installed on the front wall of the hydraulic compartment, is designed to be operated through a cable by the depressurization valve control lever on the right-side console in the cockpit.

The valve is provided with the three ports of "PRESSURE", "RETURN" and "SYSTEM". In its normal position, the port "PRESSURE" is connected to the port "SYSTEM". The port "RETURN", however, is kept closed. Force up the depressurization valve control lever to "DEPRESS", and the valve is switched to connect the port "SYSTEM" with the port "RETURN".

Thus the pressure of the down-stream side of the valve is lost into the return line, but the accumulator is closed and the pressure of the up-stream of the valve is maintained for the normal brake, and accordingly the engine-driven pump pressure rises to 3,000 psi, whereas it's delivery is reduced to null.

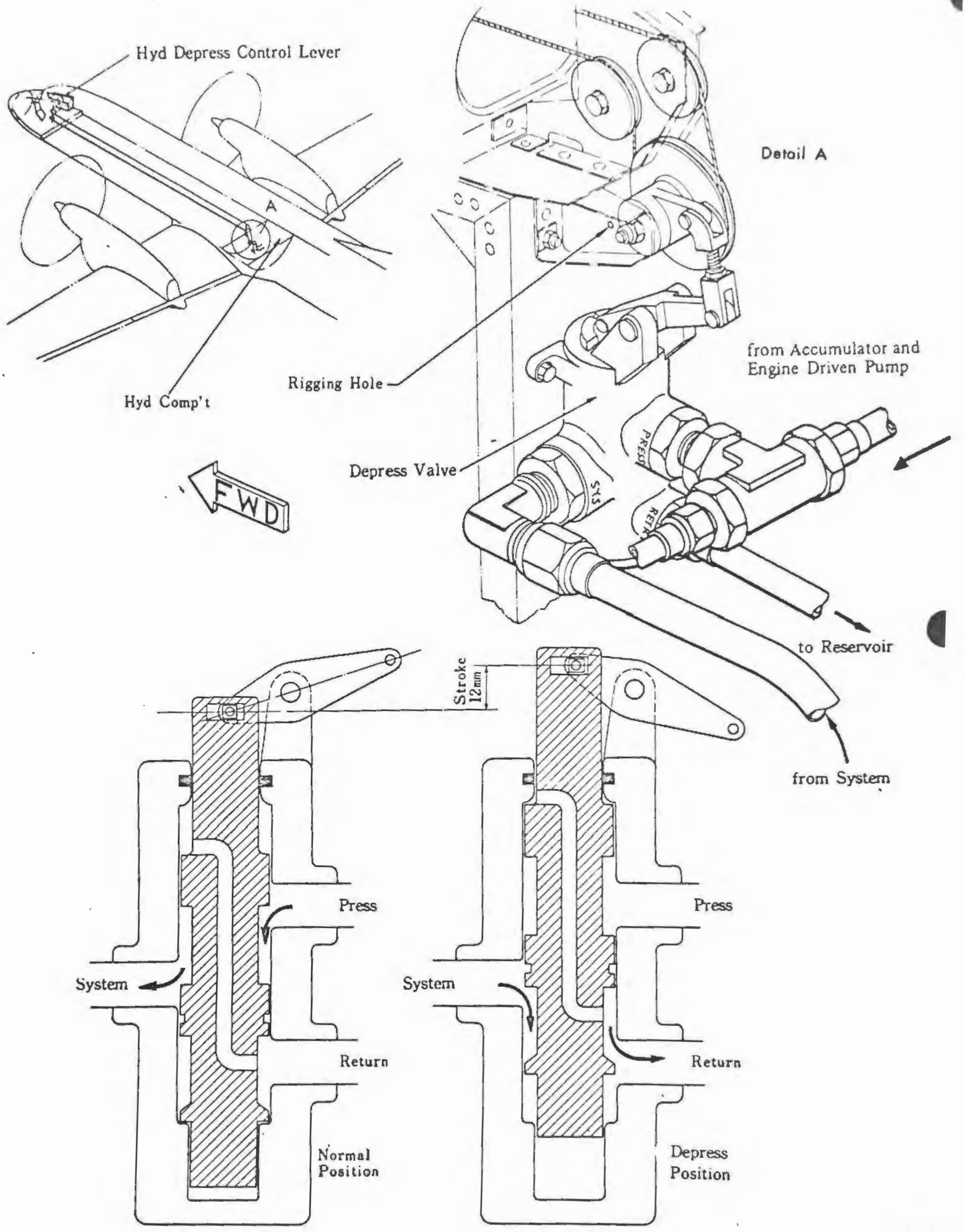


Fig 1 Hydraulic Depressurization Valve

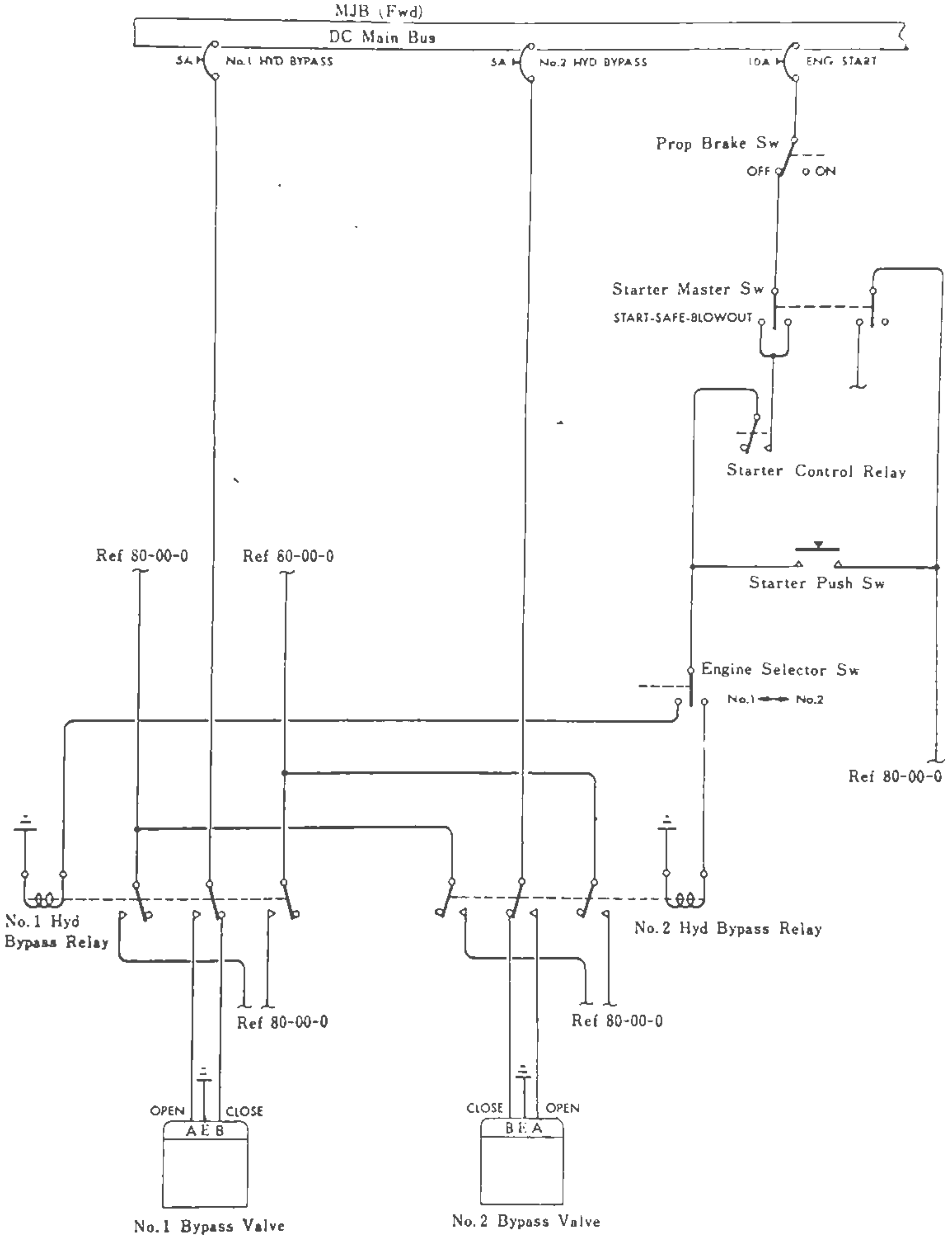


Fig 2 Start By-Pass Valve System Electrical Schematic

Auxiliary Hydraulic Power System - Description and Operation

1. GENERAL DESCRIPTION

The auxiliary hydraulic power system consists of the auxiliary hydraulic pressure source utilizing the motor-driven emergency hydraulic pump, its pressure line system and the electrical system for controlling and operating the system.

2. FUNCTION

A. As the Normal Hydraulic Source.

(1) Hydraulic pressure source of the emergency brake system. (The emergency brake has no other hydraulic pressure source.)

(2) Hydraulic source for operating the stairway in case of the failure of the engine. (The use of the battery of the aircraft as its source should be held to the least extent as much as possible.)

(3) Auxiliary hydraulic pressure source for maintenance work. (When a great rate of flow is required, use the hydraulic test stand.)

B. As the Emergency Hydraulic Source.

(1) Hydraulic source for the operation of the landing gear, steering and flap systems.

(2) Hydraulic source for operating the normal brake system. Namely, the motor-driven pump has been designed to be operated as the hydraulic pressure source in case the main hydraulic power becomes unserviceable, during the flight, even though the depress lever is in the "DEPRESS" position.

3. FEATURES

The auxiliary hydraulic power system uses the positive-displacement type pump and the pressure is regulated by the system relief valve of the emergency pump.

4. COMPOSITION

A. Emergency Hydraulic Pump (See Figure 2)

The emergency hydraulic pump is a positive-desplacement type pump produced by Vickers Limited, It is installed in the L.H. wing fuselage fillet. It is designed to be operated by a 28V DC motor. Displacement is 1.1 GPM at 3,000 psi.

B. Emergency Hydraulic Filter

The filter is suspended with the two bolts at the center in the front of the hydraulic compartment. It is an ordinary type 10μ high-pressure filter, which is provided with a built-in by-pass valve for smooth flow of hydraulic pressure even when the filter element is loaded with dirts.

C. Check Valve.

Three check valves in all are used each at the place where the emergency pressure line enters the following system.

(1) Landing gear, steering, flap, system relief valve.

(2) Normal brake, system accumulator (down stream of the depressurization valve)

(3) Emergency brake and its accumulator

All these three check valves are located in the hydraulic compartment.

D. Emergency Hydraulic Pump Relay.

The emergency hydraulic pump relay is situated at the left, upper corner inside a block located at the extremely right, lower part on the back of the main junction box. The duty of the relay is to switch on and off the electric power source for the emergency pump motor.

E. Switch and Light (See Figure 1)

The emergency hydraulic pump switch and the emergency pump indicating light are located at the lower part of the copilot flight instrument panel.

F. Circuit Breaker and Fuse

(1) The circuit breaker is located behind the copilot, on the right lower part of the Forward CB panel. It is indicated by "EMER. HYD. PUMP CONT".

(2) The fuse is in the main junction box. The 100A fuse is attached directly on the emergency bus of the DC bus located at the front, right side of the main junction box. The 1A fuse is immediately on the right of the relay described in Paragraph D, that is, in one block at the rear, right lower part of the main juction box.

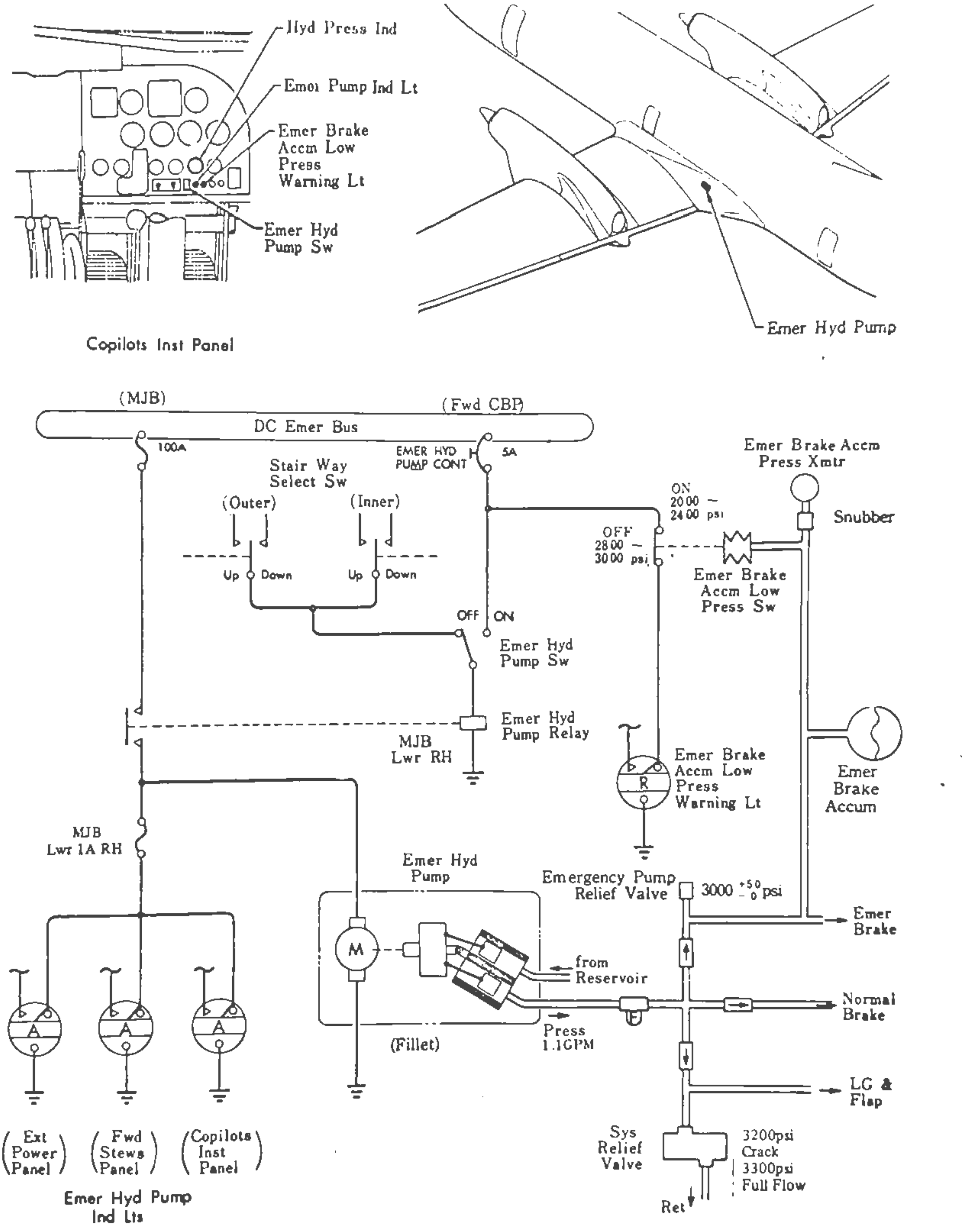


Fig 1 Emergency Hydraulic Pump Control System

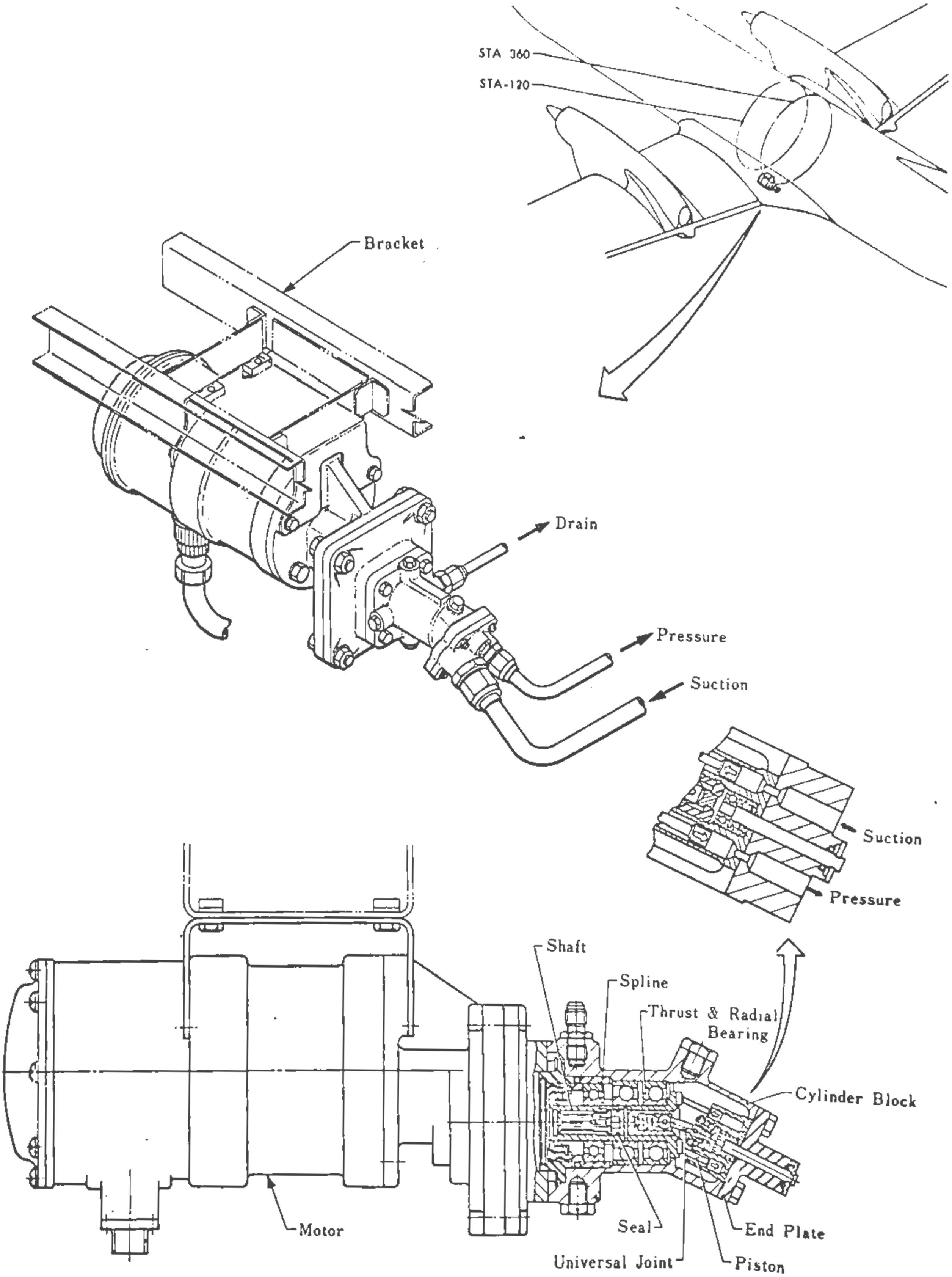


Fig 2 Motor Driven Emergency Hydraulic Pump

5. OPERATION

A. Operation of the Electrical System (See Figure 1)

NOTE

> The power source is the emergency bus only. Accordingly in case only the battery is serviceable as the power source of the aircraft, remember to switch the battery switch or the power control switch to "BATT".

When the emergency bus is being supplied with electric power, turn on the emergency hydraulic pump switch in front of the copilot, and the emergency hydraulic relay in the main junction box is actuated.

The DC28V power, therefore, flows through the 100A fuse to the emergency pump. At this time, the emergency hydraulic pump indicating lights each on the copilot flight instrument panel, forward stewardess panel if installed and external power panel are simultaneously lit.

When the stairway selector switch is forced "UP" or "DOWN" even if the emergency hydraulic pump switch is in the "OFF" position, the emergency pump turns. As for the details of the stairway electrical system, see 52-62-0, Figure 2.

B Operation of the Hydraulic System (See Figure 1)

The suction port of the hydraulic reservoir on the emergency side is located at a lower part than that on the main system side. Therefore, even when no hydraulic fluid on the main hydraulic system side, the 2.06 gallons (7.8 lit.) hydraulic fluid remains on the emergency system side, and can be used by the emergency pump.

The hydraulic fluid whose pressure is increased by the emergency pump, is divided into three systems in the hydraulic compartment after passing through the filter.

Of the three, there is the line which leads the fluid to the emergency pump relief valve. The fluid led to the valve is regulated to the desirable pressure. The line extending to the emergency brake system is provided with a low-pressure warning switch, which serves to put on the red light when the pressure of the emergency accumulator drops down below 2,000 to 2,400 psi.

When the red light is lit, the copilot should turn the emergency hydraulic pump switch "ON". As to the description of the pressure warning light and indicating system, see 29-32-0.

Auxiliary Hydraulic Power System - Operational Test

1. GENERAL

This test is made on the operation of the emergency hydraulic pump, the emergency pump relief valve of the hydraulic system, and the electrical system of this system.

2. PREPARATORY WORK

A. Connect the external electric power source.

B. Turn on one of the inverter switches on the overhead L. H. panel; and close the circuit breaker of "INST TRANS NO. 2" on the aisle side.

C. Close the "HYD PUMP CONT" circuit breaker on the forward circuit breaker panel.

D. Set the selector switch of the hydraulic pressure gage of the aircraft located at the lower part of the copilot flight instrument panel to the "EMER" position.

E. Depress the brake pedal to remove the pressure from the hydraulic system accumulator and check the air pressure.

F. Remove the pressure of the emgergency brake accumulator through the pressure dump valve and check the air pressure.

G. Place the depress valve control lever to the "DEPRESS" position.

H. Prepare for a stop watch or a wrist watch with a center second pointer.

3. TEST

NOTE

During the following test, do not operate the landing gear, flap, steering, and the brake.

A. Make certain that the emergency brake accumulator low-pressure warning light is "ON".

B. Turn the emergency hydraulic pump switch "ON" and simultaneously start the stop watch.

C. Watch the emergency accumulator pressure. The low-pressure warning light must go out when the pressure increased to 2,800 psi to 3,000 psi.

D. When the low-pressure warning light went out, stop the stop watch. At this time, the time required should be within one minute.

E. Drive the emergency hydraulic pump for another one minute. At this time, the emergency accumulator pressure should be 3,000 to 3,050 psi.

F. Stop the emergency hydraulic pump.

4. POST-WORK

A. Full out the circuit breakers which were pushed in the circuit breaker panel in the aforementioned paragraph 2.

B. Place the depress valve control lever back to the "NORMAL" position.

Hydraulic Fluid Quantity Indication System - Description and Operation

1. GENERAL

The hydraulic fluid quantity indicating system is of the electric capacity type just like the fuel quantity indicating system. The hydraulic reservoir, located in the fuselage, is less liable to temperature change as compared with fuel; and accordingly no compensator unit is in use in the system. The indicator is arranged on the copilot instrument panel and indicates by percentage the level of the hydraulic fluid (MIL-H-5606A).

2. COMPONENTS (See Figure 1)

The following parts of this system are the products of Hokushin Electric Works, Ltd.

Nomenclature	Type	Item No.	Qty/ac	Location
Tank unit	PF53-N2	29-31-1	1	Hyd. reservoir
Indicator	PF22-N3	29-31-3	1	Copilot instr. panel
Amplifier	PF05-N3	29-31-2	1	Lowest part of MJB
Shock mount	PF99	-	1	Lowest part of MJB

3. FUNCTION (See Figure 2 and 3)

Like the fuel quantity indicating system, the hydraulic fluid quantity indicating system is composed of tank unit, amplifier, and indicator

When the electrostatic capacity of the tank unit varies with the variation of the level of the hydraulic fluid, the bridge circuit is unbalanced and generates electric signals. The signal is amplified by the amplifier and transmitted to the servo motor which drives the indicator to turn the index.

The servo motor functions to regulate the electric voltage of the bridge circuit by means of the gearing and at the same time energizes the potentiometer to balance the bridge circuit again.

The index position at this time is at the level of the hydraulic fluid. As regards the principle of the capacitance bridge operation, see the description given in Page 1, 28-41-0.

4. TEST SWITCH CONTROL

The hydraulic quantity test switch is arranged on the copilot's instrument. Turn the switch "ON", and the index moves toward zero. Contrarily, when the switch is turned "OFF", the index returns to the original value.

CAUTION

At the point slightly toward the minus side from the zero of the indicator, there is the stop for the index. During the test, remember that the index should never be returned till it comes into contact with the stop.

5. POWER SOURCE AND CIRCUIT PROTECTION

The hydraulic fluid quantity indicator is supplied with electric power from the CF main bus C phase through the 5A hydraulic quantity circuit breaker on the circuit breaker panel on the aisle side.

Hydraulic Pressure Indication and Warning System - Description and Operation

1. GENERAL DESCRIPTION

This system designed to indicate the pressure in the hydraulic system is dividable into the following three systems.

Pressure Indicating System of the Main Hydraulic System
Pressure Indicating System of the Emergency Brake Accumulator
Pressure Drop Warning System of the Emergency Brake Accumulator
Engine Driven Pump Warning Light

2. COMPOSITION

	Nomenclature	Q'ty	Location	Specification
A	Hyd Press Ind	1	Copilot Instr Panel	MS28010-5
B	Main Hyd Press Xmtr	1	Hyd Compt	MS28005-5
C	Emer Brake Accm Press Xmtr	1	Hyd Compt	MS28805-5
D	Emer Brake Accm Low Press Sw	1	Hyd Compt	Open at 2,800 to 3,000 psi Close at 2,000 to 2,400 psi
E	Emer Brake Accm Low Press Warning Lt.	1	Copilot Instr Panel	Push-to-Test Red Light
F	Hyd Press Selector Sw	1	Copilot Instr Panel	AN3226-3
G	Circuit Breaker			
	"INSTR TRANS No. 2"	1	Aisle Side CB Panel	5A
	"EMERG HYD PUMP CONT"	1	Fwd CB Panel	5A
H	Fuse "HYD PRESS IND"	1	Fwd Fuse Panel	1A
J	"INSTR TRANS No. 2"	1	DC Main Junction Box	
K	Engine Driven Pump Press Sw	2	Hyd Compt	Open at 2,700 to 2,900
L	Engine Driven Pump Warning Light	2	Copilot Instr Panel	Close at 900 to 1,100

A. Hydraulic Pressure Indicator

B. Main Hydraulic Pressure Transmitter

(2) "EMERG HYD PUMP CONT" 5A

This circuit breaker is situated at the right lower part of the circuit breaker panel on the bulkhead behind the copilot.

Pull the circuit breaker, and the emergency hydraulic pump control circuit is also opened.

H. Fuse "HYD PRESS IND" 1A

This 1A fuse has been installed on the fuse panel at the upper part of the bulkhead behind the copilot. The fuse serves to avoid giving undesirable influence on the No. 2 engine hydraulic pressure and fuel flow indicating system in case a trouble has taken place in the hydraulic pressure indicating system. When the fuse is burned down, the neon tube of the fuse emits amber light.

J. No. 2 Instrument Transformer (Ref).

No. 2 instrument transformer belongs to the instrument transformer. Open the panel at the right, upper corner in the wall behind the copilot, and you will see two transformers in a row. The outside (right) transformer is this No. 2 instrument transformer.

K. Engine Driven Pump Press. Switch.

The engine driven pump press. switch is provided in the engine driven pump press. line, up-stream of the check valve (in the hydraulic compartment). When the pump on one side is functioning normally and the system pressure is raised to the specified pressure, if the pump on the other side fails and the pressure does not build up, the pressure up-stream of the check valve will not build up and consequently the warning light continues to light notifying of the failure of the pump.

L. Engine Driven Pump Low Press. Warning Light.

These warning lights are installed on the copilot's instrument panel and are put out respectively when the pump pressures reaches 2,700 psi and are lit when it decreases below 900 to 1,100 psi.

3. OPERATION

A. Operation of the Pressure Indicating System.

Connect the external power source to the aircraft and turn either of the inverter switches on the overhead panel (L.H.) "ON", and electric power is supplied to the CF emergency bus. The electric power is AC115V.

The power goes to the No. 2 instrument transformer, where it is lowered to 26V, subsequently flowing through the fuse to the hydraulic pressure selector switch and indicator rotor on the copilot instrument panel.

Set the selector switch to "NORM", and the AC 26V power flows to the transmitter on the main hydraulic side to energize the rotor of the transmitter, generating, an alternating field. The rotor is electrically connected to the Bourdon's tube and turns in accordance with pressure.

In each phase of the star-connected stator winding, an electric voltage corresponding to the correlative position with the rotor is generated. This generated voltage reproduces an alternating field in the same direction at the stator winding of the indicator.

The indicator rotor is turned by mutual action between these alternation fields, making its index indicate the hydraulic pressure.

Set the selector switch to "EMERG", and the indicator also indicates the pressure in the emergency brake accumulator.

B. Operation of the Pressure Drop Warning System.

The electric power flowing from the DC emergency bus through the circuit breaker "EMERG HYD PUMP CONT" 5A reaches the emergency brake accumulator low-pressure switch. While the accumulator pressure is over 2,800 to 3,000 psi, the pressure switch contact is open.

However, when the accumulator pressure is below 2,000 to 2,400 psi, the contact is kept closed. Therefore, the electric power flows to the emergency brake accumulator low-pressure warning light of the copilot's instrument panel. Thus, the warning light comes on.

NOTE

The indication of pressure indicator is made up of the nominal value, the following instrument errors and the effects of reservoir pressurization:

Error of pressure transmitter	± 50psi upto 3,000 psi ± 75psi upto 3,500 psi
Error of pressure indicator	± 20psi
Error due to reservoir pressure	25 to 30 psia (10 to 15 psig)

System		Function	(1)	(2)	(3)	(4)	(5)	(6)
Principal Flight Control System	Aileron	Wheel, R/H rotation	Violet	Yellow		Violet	-	
		Wheel, L/H rotation	"	"		"	Brown	
	Rudder	R/H pedal, pushed	"	Green		"	-	
		L/H pedal, pushed	"	"		"	Brown	
	Elevator	Column, pulled	"	Red		"	-	
		Column, pushed	"	"		"	Brown	
Trim System	Aileron	Knob, R/H rotation	Blue	Yellow		Blue	-	
		Knob, L/H rotation	"	"		"	Brown	
	Rudder	Knob,R/H rotation	"	Green		"	-	
		Knob,L/H rotation	"	"		"	Brown	
	Elevator	Knob,rearward rotation	"	Red		"	-	
		Knob,forward rotation	"	"		"	Brown	
Auto Pilot System	Aileron	Wheel, R/H rotation	White	Yellow		White	-	
		Wheel, L/H rotation	"	"		"	Brown	
	Rudder	R/H pedal, pushed	"	Green		"	-	
		L/H pedal, pushed	"	"		"	Brown	
	Elevator	Column, pulled	"	Red		"	-	
		Column, pushed	"	"		"	Brown	
	Elevator Trim	Knob, rearward rotation	"	"		Blue	-	
		Knob, forward rotation	"	"		"	Brown	

Reserved

Start - by-Pass Valve System/Operational Test

WARNING

1. It is necessary to observe the following precautions lest the engine should start running during the operation test. Above all, it is important to pay attention to the position of the circuit breakers.

2. Be sure that the propeller rotating plane is clear of personal and ground equipment considering the possibility of unexpected engine starting.

1. PREPARATION

A. Connect the external power source to the âirplane and set the circuit breakers and switches as follows:

Batt. switch	"EXT"
Engine start	"ON"
Main bus volt	"ON"
Selector relay	"OFF"
Ignition (4 ea.)	"OFF"
Hyd. by-pass	"ON"
Prop. brake switch	"OFF"
Starter master switch	"SAFE"
Engine selector switch	"OFF"

2. TEST

A. Under the above conditions, make sure that the start by-pass valve is in the closed position.
Make sure that the valves remain in the closed position even if the engine selector switch is set to No. 1 or No. 2 position and, then, turn off the engine selector switch.

B. Set the starter master switch to "START" or "BLOW OUT".
Make sure that the valves are in the closed position.

C. Set the engine selector switch to No. 1. Make sure that the valve of L.H. pump line is closed when the starter master switch is in "SAFE" position and that the valve opens when the starter master switch is set to "START" or "BELOW OUT" position.

D. Make sure that the valve of L.H. pump line is in the closed position when the engine selector switch is set to "No. 2" position no matter whether the starter master switch is in "START" or "BELOW" position.

E. Repeat same procedure of (c) (d) for the valve of R.H. pump line.

C. Emergency Brake Accumulator Pressure Transmitter.

The transmitter has been installed with four bolts immediately forward the transmitter referred to in the preceding paragraph, on the shock mount of the right panel in the hydraulic compartment.

The transmitter is connected to the emergency brake accumulator line. It is interchangeable with that of the main hydraulic pressure.

A snubber is provided in the upstream side of the transmitter in order to keep away the sudden pressure change of this line.

D. Emergency Brake Accumulator Low-pressure Switch.

This pressure switch has been fixed with two bolts at the rearmost part of the right-hand wall of the hydraulic compartment. Electrically, it is a normal close-contact type pressure switch.

When the pressure of the emergency brake accumulator has dropped to 2,000 to 2,400 psi or lower, the switch is operated "ON".

On the contrary, when the pressure has reached 2,800 to 3,000 psi, the switch is moved "OFF". The switch is connected with a pressure sensing line and an electrical connecting plug.

E. Emergency Brake Accumulator Low-pressure Warning Light.

The warning light is located immediately under the hydraulic pressure gauge of the copilot's instrument panel. The warning light serves to show the pressure drop of the emergency brake accumulator below the specified value (2,000 to 2,400 psi).

The color of the light is amber. Electrically, the warning light is a push-to-test light designed to come on at DC28V.

F. Hydraulic Pressure Selector Switch.

This switch is a kind of 2-positioned selector switch installed immediately under the hydraulic pressure gauge on the copilot's instrument panel.

Turn the switch up to "EMER", and the hydraulic pressure gauge indicates the pressure in the emergency brake accumulator. On the contrary, place the switch down to "NORM", and the gauge shows the pressure in the main hydraulic system.

G. Circuit Breakers

(1) "INSTR TRANS No. 2" 5A

This circuit breaker is located, a little frontward, at the one-third height, from above, of the aisle-side circuit breaker panel.

Pull the circuit breaker and the No. 2 engine hydraulic pressure and fuel flow indicators are stopped to work simultaneously.

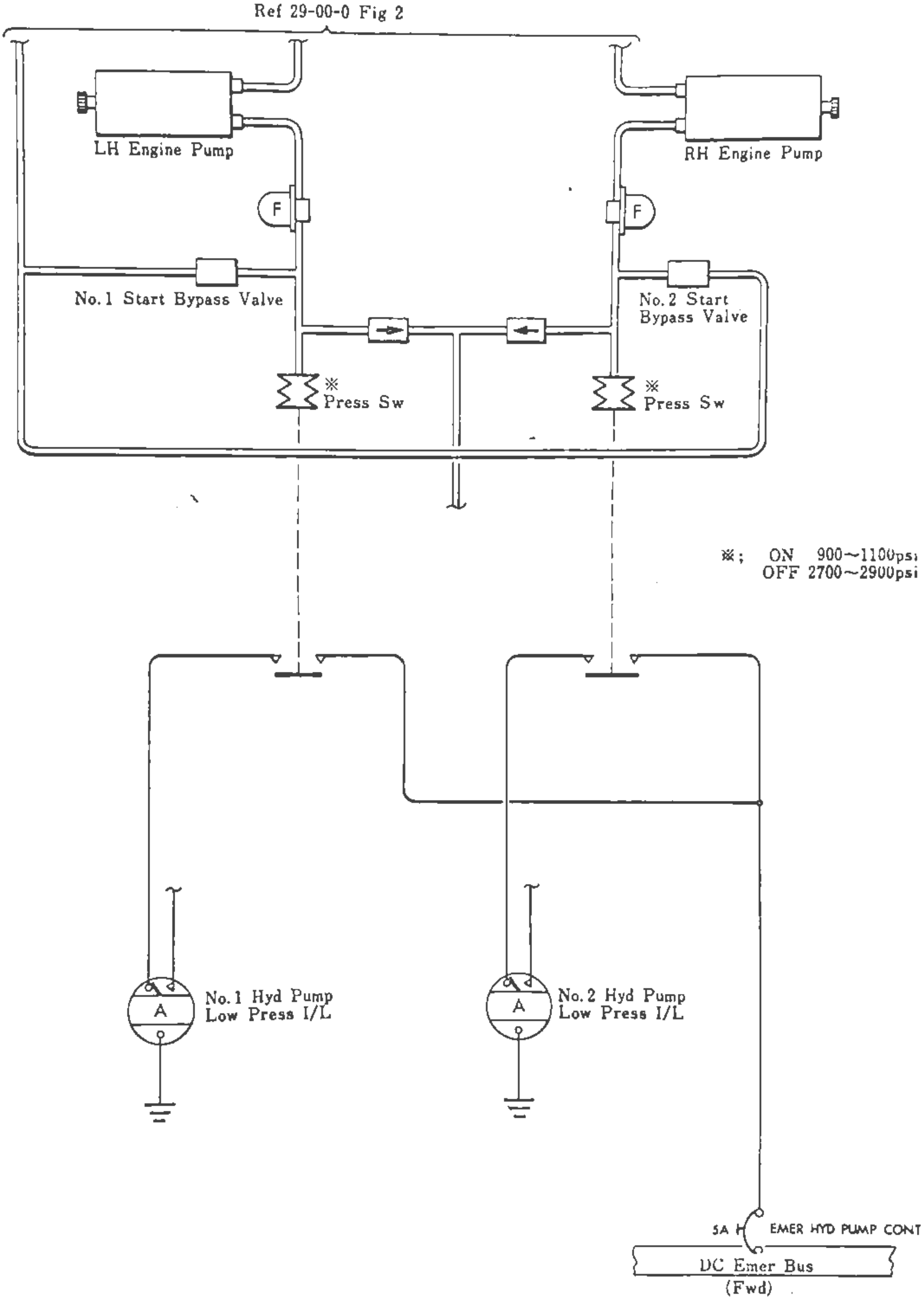


Fig 1 Engine Driven Pump Warning and Indicator System

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Chapter 7 Flight Control System

7.1 General

7.1.1 Principal Flight Control System

The aileron is provided with a spring tab and a trim tab, the rudder is provided with a tab which can be used as a spring tab and a trim tab and the rudder is provided with a ~~balance~~ spring tab and a trim tab.

All the control surfaces of dual control type are controlled manually and control wheels, columns and pedals are provided for the pilot and the co-pilot. These controllers and the control surfaces are connected with cables and push-pull rods. On the center pedestal are provided control knobs and indicators for each trim, the trim angles being shown on the indicators.

7.1.2 Flap

The flap of Fowler type is actuated hydraulically. The flap control is conducted electrically by a flap control switch which is located on the center pedestal.

The flap is provided with an asymmetry protection unit. If the angles of the L.H. and the R.H. flaps differ by 1° to 3.5°, for some reason or other the electric control circuit is interrupted, stopping the flaps automatically to stop the agravation of the asymmetry.

7.1.3 Angles of Control Surfaces

Control Surface		Position	Angle
Aileron	Aileron	Up Down	24° ± 1° 15° ± 1°
	Spring Tab	Up Down	18° ± 0.5° 10° ± 0.5°
	Trim Tab	Up Down	21° ± 0.5° 21° ± 0.5°
Rudder	Rudder	L.H. R.H.	22° ± 0.5° 22° ± 0.5°
	Spring Tab	L.H. R.H.	21° ± 0.5° 21° ± 0.5°
	Trim Tab	L.H. R.H.	12.5° ± 0.5° 12.5° ± 0.5°
Elevator	Elevator	Up Down	27° ± 0.5° 13° ± 0.5°
	Balance Tab	Up Down	5.9° 12.2°
	Trim Tab	Up Down	10° ± 0.5° 15° ± 0.5°

Flap Angle $35^{\circ}\,{}^{+0^{\circ}}_{-1^{\circ}}$

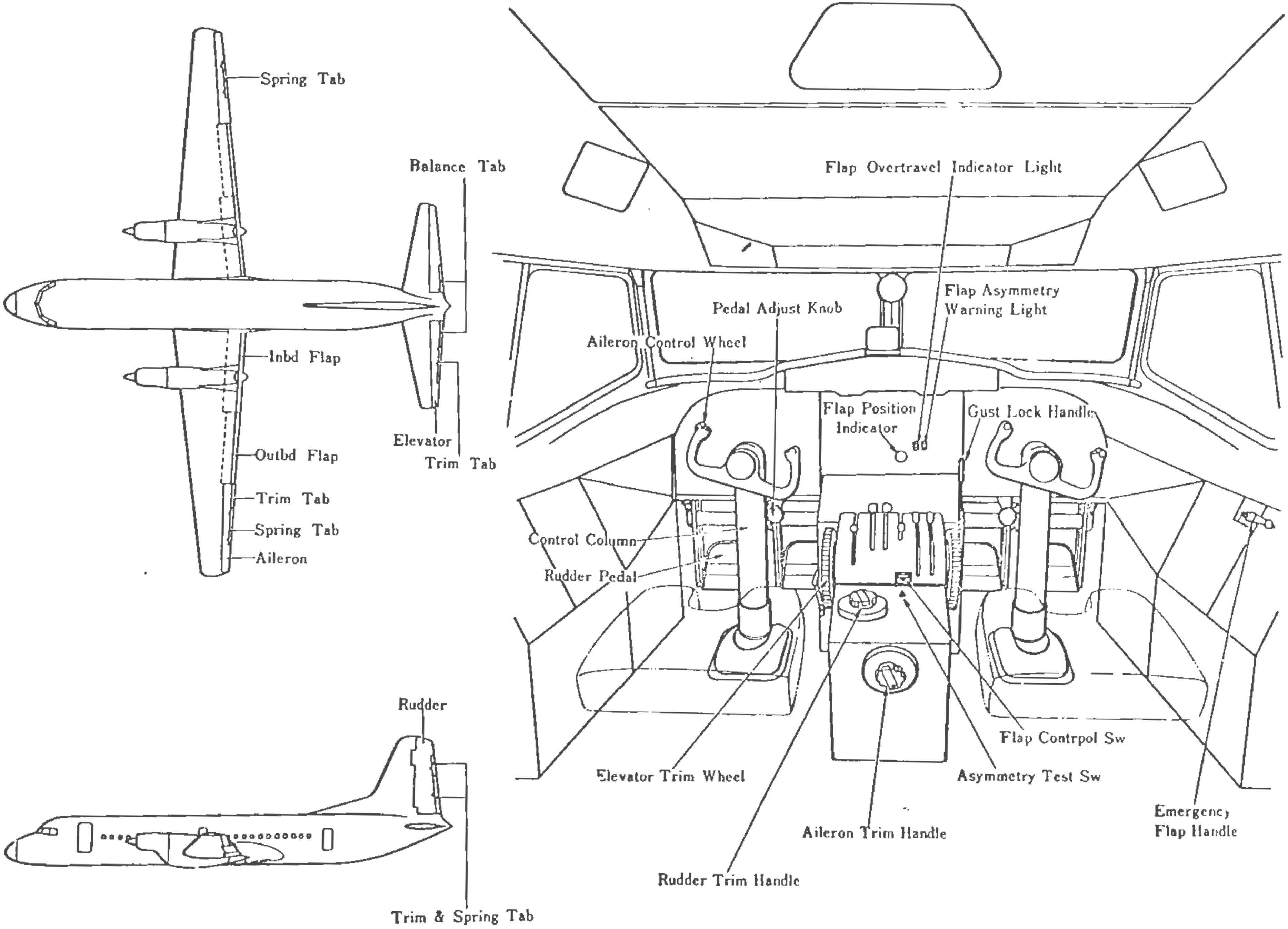
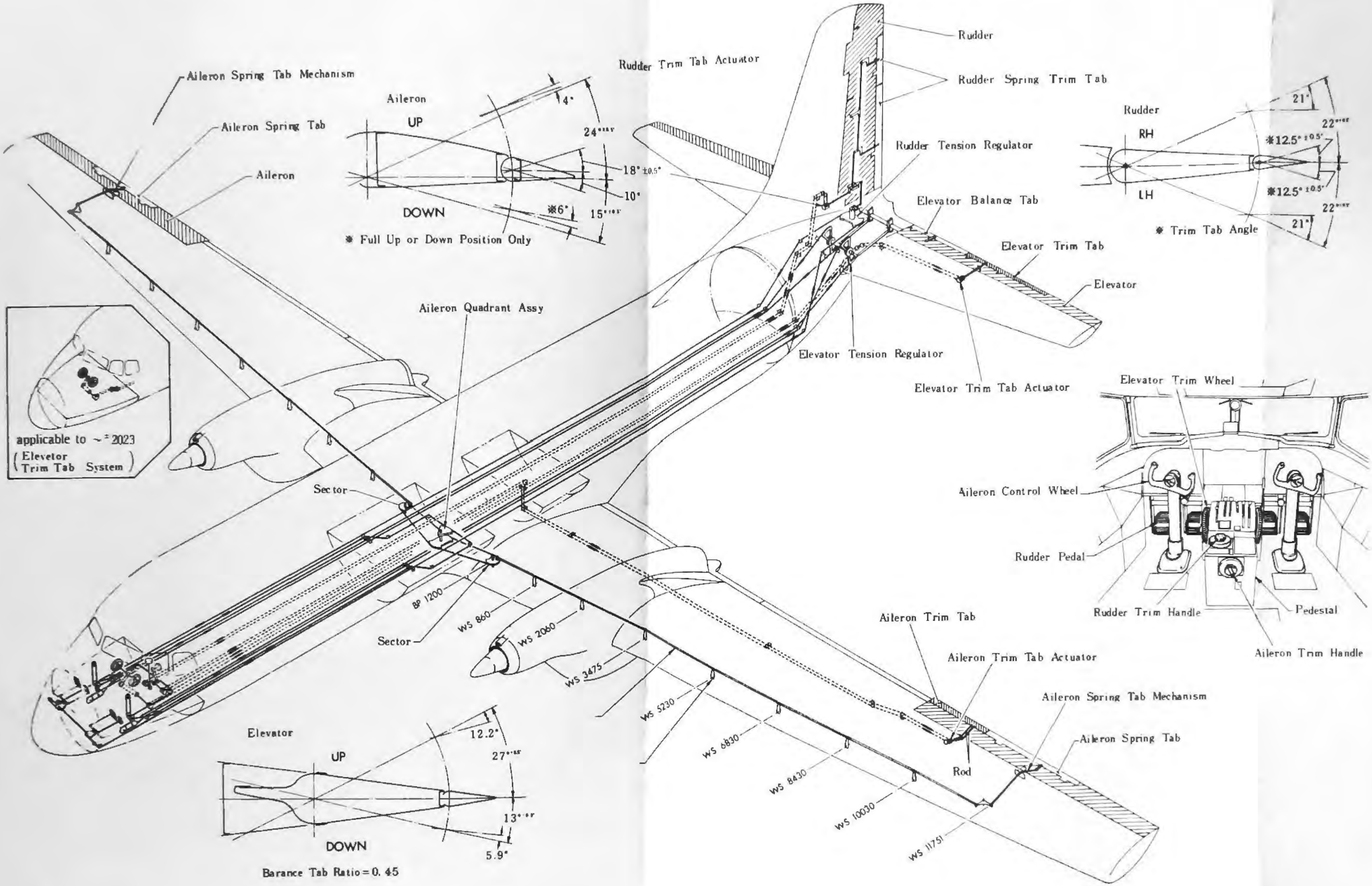


Figure 7-1
Flight Control



Fight Control System
Figure 7-2

7.1.4 Gust Lock

The three flight control surfaces are provided with the gust lock units, fixing them in the neutral position while the aircraft is parked to avoid damage to them. Between the gust lock lever and the low stop lever (power control lever) is provided an interlocking mechanism which prevents accidents due to misoperation in flight.

NOTE: For the interlocking mechanism, see Chapter 5, POWER PLANT.

7.1.5 Control Cable and Cable Tension Regulator

In the control system of the rudder and the elevator running through the entire fuselage are provided the cable tension regulators which maintain the cable tensions at certain values, independent of the variation of the outside air temperature.

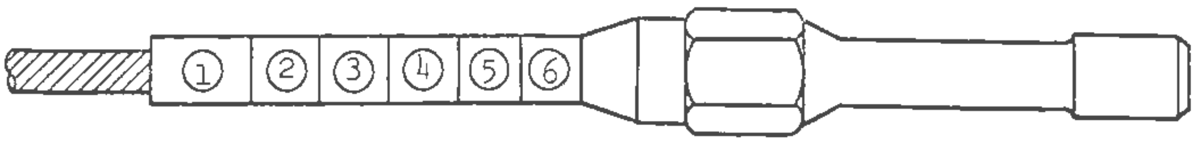
The aileron control system is not provided with the cable tension regulators.

The control cable is made of carbon steel (MIL-C-1511).
The sizes in use are as follows:

Principal control system	3/16 in. dia.
Trim systems	3/32 in. dia.

The fuselage pressure bulkheads through which the control cables pass are sealed for air tightness.

For cable identification, identification tapes are wound around the cable terminals so that the cables can be identified by the position, color and arrangement of the tapes. The relationship of the cables and the identification tapes is shown below.



System		Function	(1)	(2)	(3)	(4)	(5)	(6)
Gust Lock	Aileron	Lock	Orange	Yellow		Orange	-	
		Unlock	"	"		"	Brown	
	Rudder	Lock	"	Green		"	-	
		Unlock	"	"		"	Brown	
	Elevator	Lock	"	Red		"	-	
		Unlock	"	"		"	Brown	
	Where 3 control surfaces or 2 control surfaces are joined together	Lock	Orange				-	
		Unlock	"				Brown	
Flap	Emer flap	Up	Blue		Yellow		-	
		Down	"		"		Brown	
Hydraulic Control System	Nose steering	Wheel, R/H rotation	Yellow				-	
		Wheel, L/H rotation	"				Brown	
	By-pass V. (Depress V)	Normal	Blue				-	
		By-pass (Depress)	"				Brown	
	L/G control V.	Up	White				-	
		Down	"				Brown	
	Normal brake	On	Green				-	
		Off	"				Brown	
Power Plant Control System	H.P.C.	H.S.W.	Green	White		Green	-	
		Off	"	"		"	Brown	
	Throttle	R.P.M. Increase	"	Red		"	-	
		R.P.M. Decrease	"	"		"	Brown	
Emergency Control System	Emer brake	-	Red		White		-	
	Emer up lock release	-	Orange		Green		-	

Note: Hydraulic, power plant and emergency control systems have been described above for references.

7.1.6 Air Seal of Control Surfaces

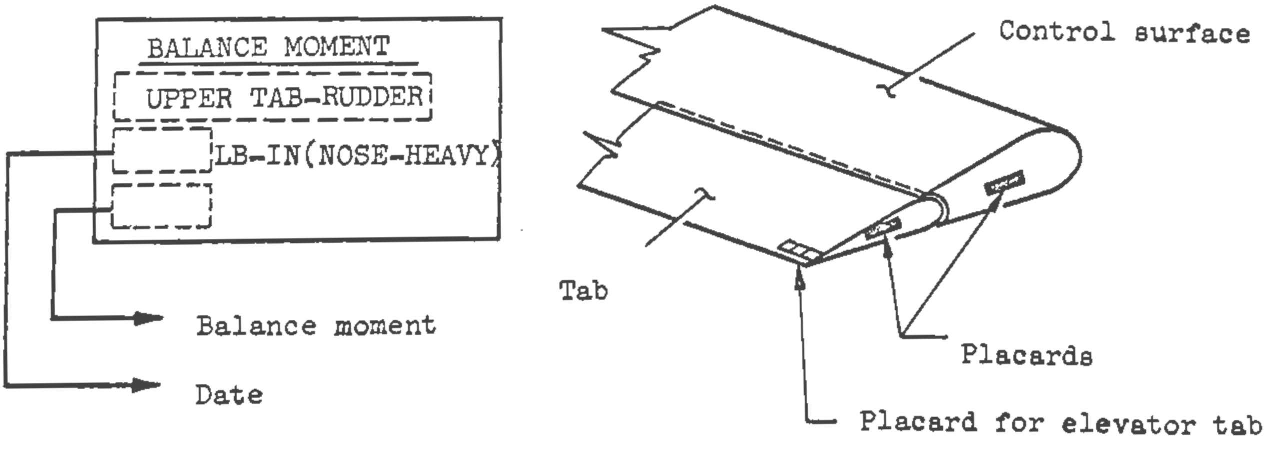
Air seal is provided on all flight control surfaces except the flaps. The air seal is installed on the leading edge of the control surface over its entire span, sealing the gap at the attaching portion of the control surface to prevent air flows on two surfaces of the control surface (upper and lower or left and right) from mixing.

As the sealing material, cloth (curtain seal) is used on the aileron and the elevator, and rubber is used on the leading edge of the rudder. Air seal is also installed on the spring tab, balance tab and trim tab. This seal consists of polyurethane attached to the rear spar of each control surface and aluminum sheet attached to the front spar of the tab, the latter compressing the former.

The flap is sealed at its up position. On the lower surface of the wing trailing edge is provided a striker made of rubber which comes in close contact with the lower surface of the flap when it is in the up position, keeping air-tightness.

7.1.7 Surface Balance Moment

On the three control surfaces and tabs (except the aileron trim tab) are attached the placards on which the balance moments are shown. These moments were measured when the airplane was completed and the placards are attached on the root rib webs, except that those for the elevator balance tab and trim tab are located on the lower skin of the root trailing edge.



7.2 Aileron Control System

7.2.1 Attachment of Aileron

The aileron is attached to the wing trailing edge with five hinges. These hinges are numbered as follows:

No. 0 hinge	at W.Sta	9038
No. 1 hinge	at W.Sta	10162
No. 2 hinge	at W.Sta	11751
No. 3 hinge	at W.Sta	13200
No. 4 hinge	at W.Sta	14400

7.2.2 Control System (See Fig. 7-3)

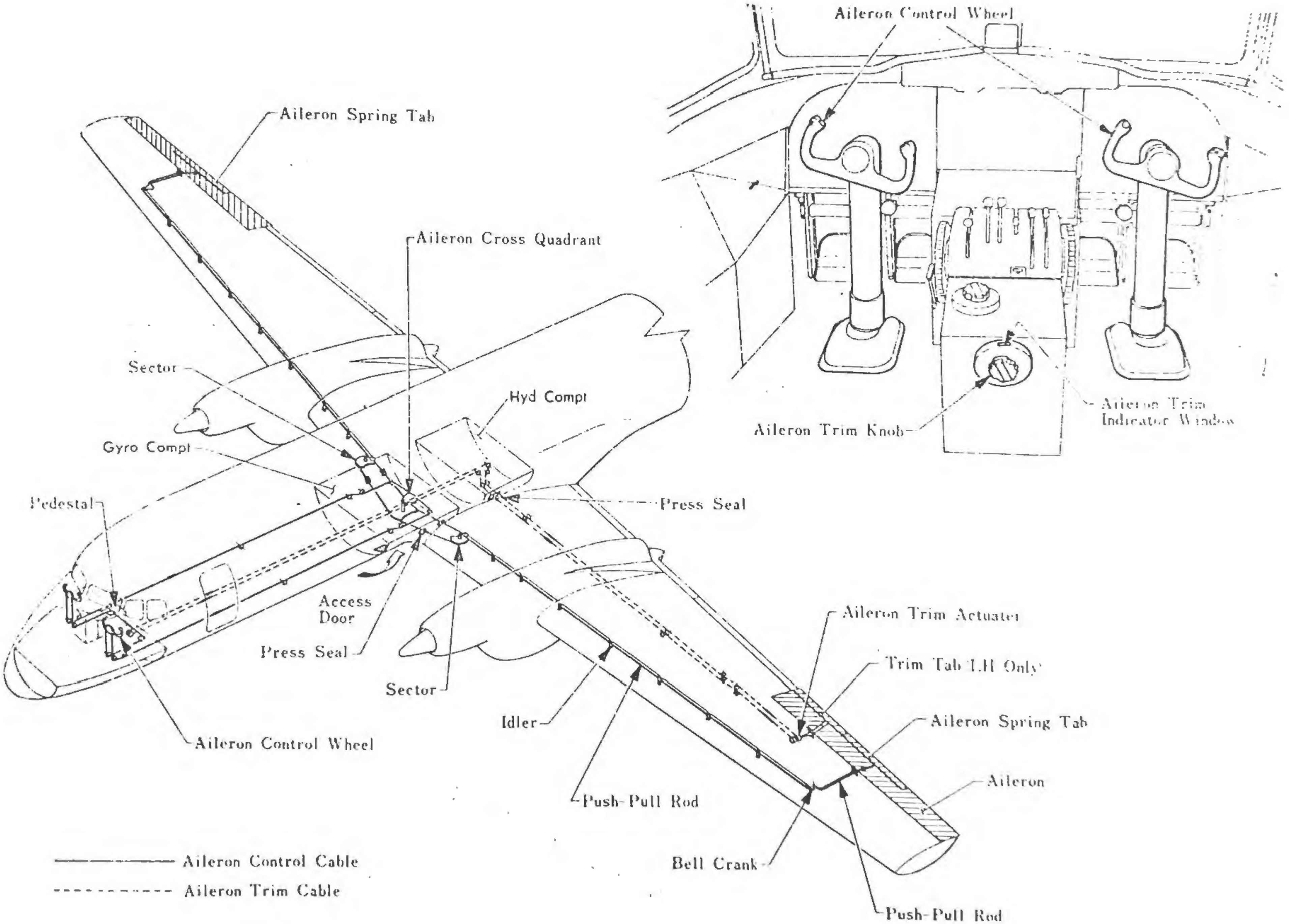
Fig. 7-3 shows the arrangement of the mechanism of the aileron control system. The aileron is controlled by rotating the aileron control wheel in the cockpit. The rotation of the wheel is transmitted to the aileron through cable and push-pull rods. The cable runs through the fuselage longitudinally and the push-pull rods run through the exhaust passage of the de-icer unit located in front of the wing front spar up to WS 11751.

In the control column heads for the pilot and the co-pilot are installed the cable drums around which two cables are wound. These cables run through the control columns to the under floor section of the cockpit. One cable is connected under the cockpit floor to the aileron control wheels for the pilot and the co-pilot. The other cable, passing through the weight saving holes of the floor beams, is connected to the upper quadrant of the aileron cross quadrant in the flight control compartment in the center of the fuselage. The aileron cross quadrant is made up of a torque tube and two quadrants (upper and lower quadrants) attached to it.

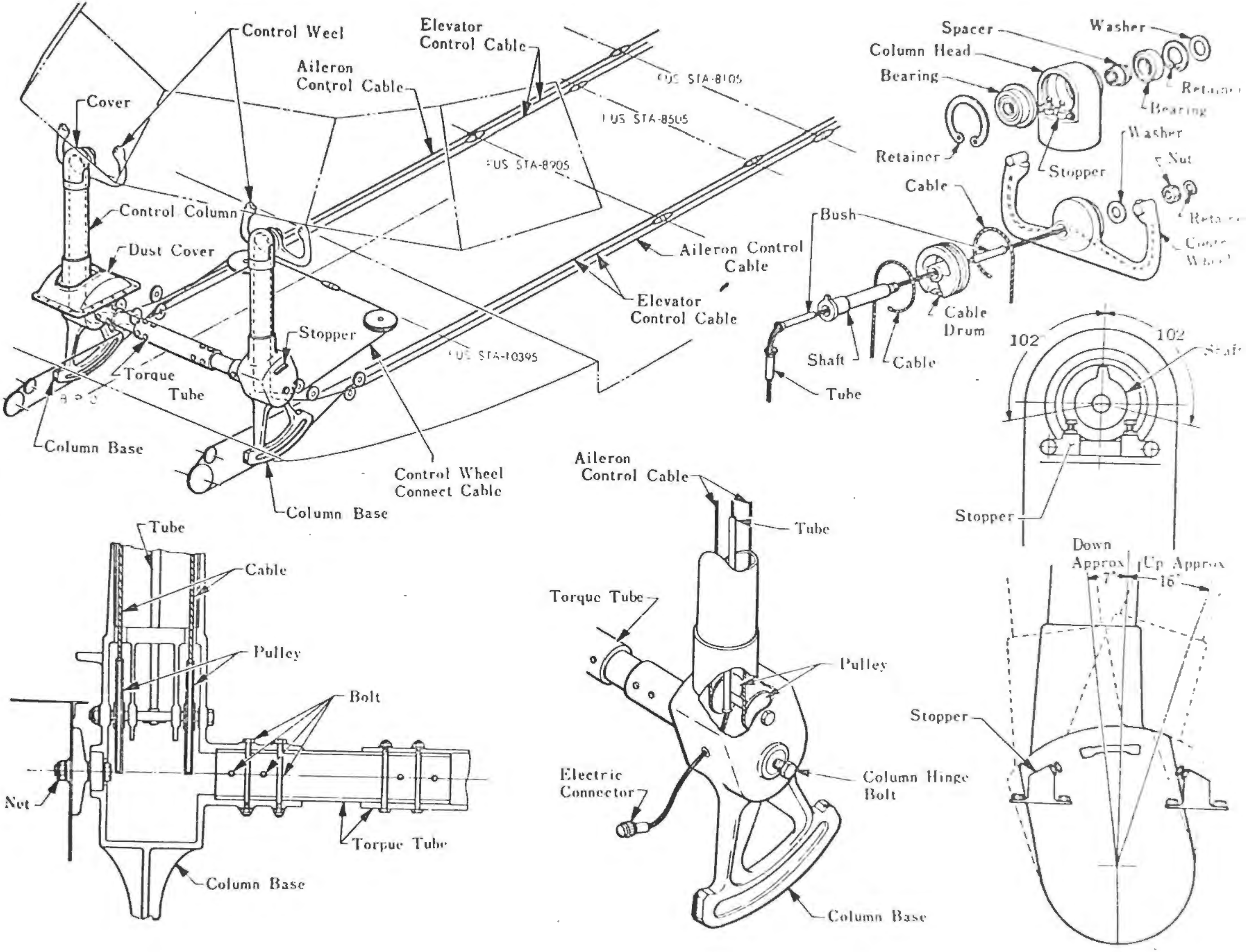
In the leading edge of the wing at its attaching section is provided a sector. To this sector is connected a push-pull rod running along the wing leading edge and it is also connected to the lower quadrant of the aileron cross quadrant in the flight control compartment with a cable.

The push-pull rod running along the wing leading edge is connected to the aileron control rod at WS 11751 through a bellcrank. The aileron control rod also serves as spring tab control rod, being connected to the aileron spring tab mechanism.

The aileron and the aileron spring tab are connected with a spring and the rotation of the aileron control wheel is transmitted to the aileron through a spring in the spring tab mechanism.



Aileron and Tab System
Figure 7-3



Control Column
Figure 7–4

Control Column Head (See Fig. 7-4)

The aileron control wheel is connected to the cable drum with a shaft with spline and the rotation of the wheel is transmitted to the drum. On the shaft is provided a protection stopper (preventing overtravelling of the control wheel) and on the column head is provided a stopper bolt.

Aileron Cross Quadrant (See Fig. 7-5)

The aileron cross quadrant is installed at F.Sta-2950, being made up of a torque tube and upper and lower quadrants attached to it. This torque tube is supported by floor beams and keel ball bearings in the lower part of the fuselage. On the lower part of this torque tube are provided the aileron bungee spring and the aileron gust lock quadrant. The aileron bungee spring is fixed to the torque tube of the quadrant and a fuselage frame, correlating the angular motion of the aileron and the control force linearly.

Push-pull Rod (See Fig. 7-5)

Eight push-pull rods of 45 mmø are connected in series in the wing leading edge with idle arms, being connected to the bellcrank at WS 11800. On the following three rods,

BP 1200 ~ WS 860

WS 8430 ~ WS 10030 and

WS 10030 ~ WS 11800

are provided rod ends so that their length can be adjusted but other rods can not be adjusted. The rod ends for length adjustment are located on idle arms and bellcrank attachments at WS 10030 and WS 11800.

7.2.3 Spring Tab Mechanism (See Figs. 7-5 and -6)

The aileron control rod is connected to the aileron through a spring. Therefore, in order to control the aileron, the tab is controlled first and then the air force moves the aileron.

7.2.4 Stopper for the System and its Functions (See Fig. 7-5)

The aileron control system has the following four stoppers:

(1) Aileron travel angle stopper

(2) Spring tab stopper

(3) Bellcrank stopper

(4) Control wheel stopper

(1) is a stopper for the aileron travel angle; a stop bolt being provided on the wing trailing edge (WS 9517) and a stopper made of aluminum alloy on the aileron leading edge which restricts the aileron travel angle.

(2) is a stopper for the spring tab, installed in the spring tab mechanism, restricting the spring tab travel angle.

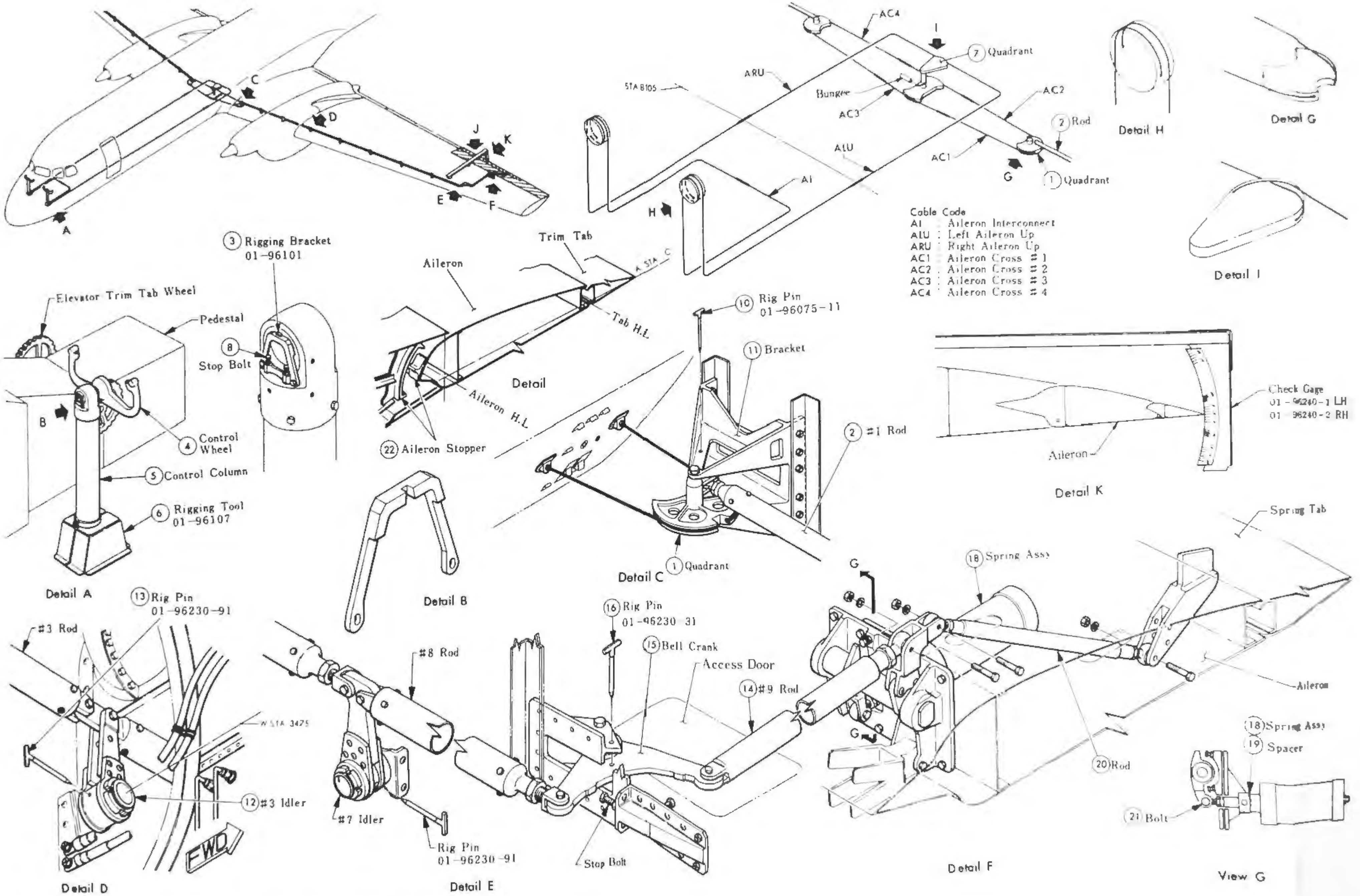
(3) is a stopper for the bellcrank, located at WS 11800, consisting of two bits, one on the forward side of the wing front spar and another on the rear side. This stopper restricts the over-travelling of the push-pull rod provided on the forward side of the wing front spar. Viewing from the control surface side, this restricts the sum of the aileron angle and the spring tab angle.

(4) is a stopper for the aileron control wheel, located on the control column head. This protects the system. After the bellcrank comes in contact with its stopper, this stopper restricts further travel, avoiding excessive force to the system.

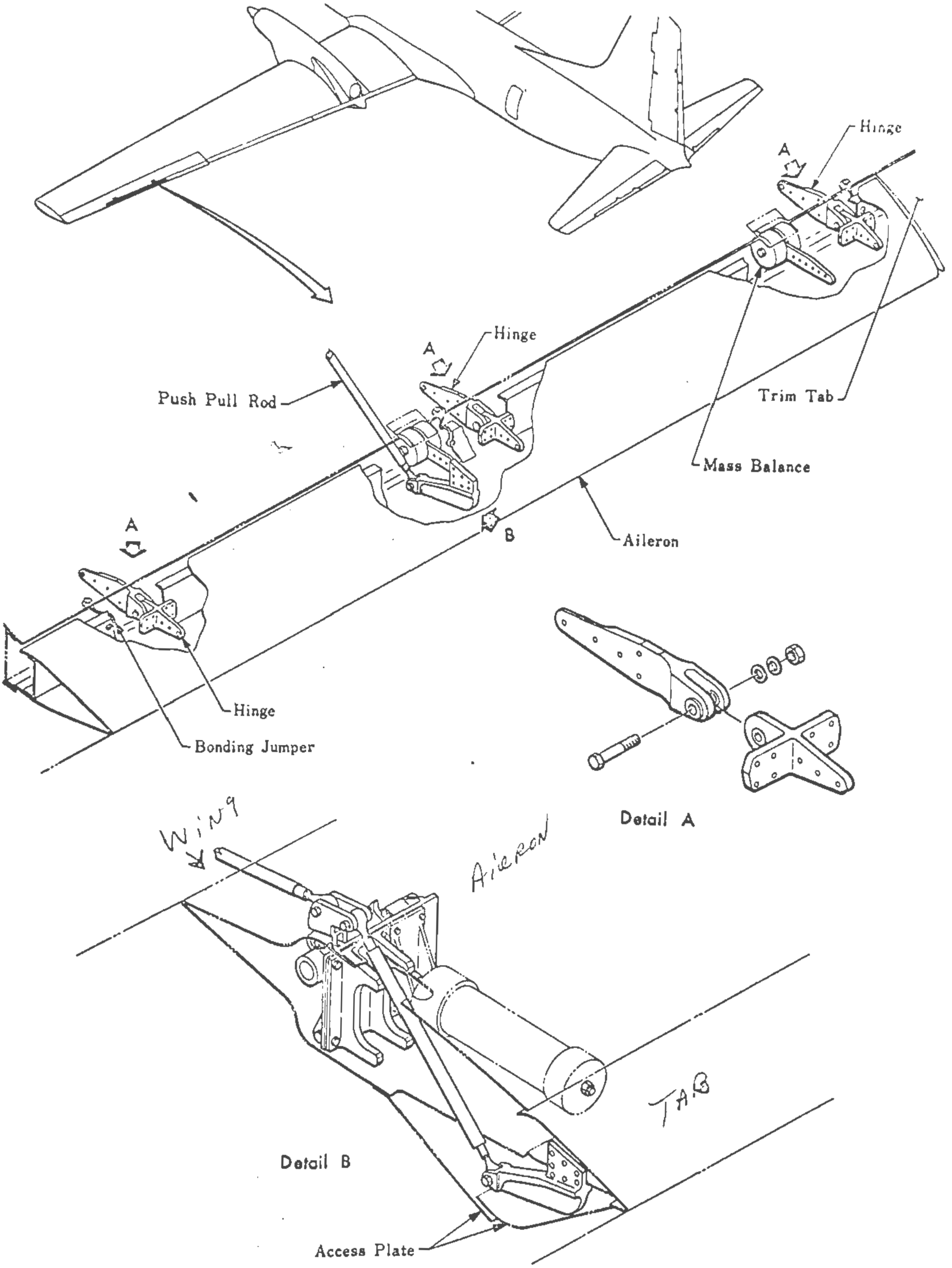
7.2.5 Procedures for the System Adjustment (See Figs. 7-4 and 7-5)

(1) Neutral Points of the System (8 locations)

Number	Fixed to	Location	Fixing Method
1	Aileron control wheel	Column head	Rigging tool
2	Control column	Column base	Rigging tool
3	Aileron cross quadrant	Flight control compartment	Gust lock "ON"
4	Sector	BP 1200	Rigging pin
5	Aileron control rod	WS 3475	Rigging pin
6	Idle arm	WS 10030	Rigging pin
7	Bellcrank	WS 11800	Rigging pin
8	Spring tab	Spring	Fixing spacer



Aileron Control System Rigging
Figure 7-5



Aileron Spring Tab Hinge
Figure 7–6

(2) Procedures for adjustment

Adjustment of fuselage side

A. Fix numbers 1 to 4 and tighten the cable in the fuselage. The cable tension is 150 lb ± 10 lb (± 1.4 lb /°F) at 70°F.

B. The position of the stop bolt of the aileron control wheel is determined lastly.

Adjustment of wing leading edge control rod

C. Fix numbers 4 to 7 and adjust the length of the control rod.

Adjustment of aileron control rod

D. Fix numbers 7 and 8 and adjust the length of the control rod, setting the aileron to 0° with a contour gauge.

Adjustment of each stopper

E. Adjust the stoppers for the aileron and the spring tab using the contour gauge used in the preceding paragraph D individually so that their respective travel angles can be obtained.

F. Adjust the bellcrank stopper so that the bellcrank begins to move when the aileron control wheel is turned by 90° ± 0.5°.

G. Adjust the stop bolt so that the aileron control wheel stopper can come into action when a load of 27 ± 1 kg is applied to a point at 165.0 R from the rotating center of the aileron control wheel after the stopper mentioned in F began to work.

NOTE: Keep removed the bungee spring in the flight control compartment.

7.3 Aileron Trim Tab Control System

7.3.1 Attachment of Trim Tab

The trim tab is attached to the aileron trailing edge with a piano hinge.

7.3.2 Trim Tab Control System (See Figs. 7-7 and 7-8)

The aileron trim tab can be controlled by rotating the control knob on the center pedestal in the cockpit. The pedestal is provided with an indicator box which shows the amount of the aileron trimming (trim tab angle).

The rotation of the control knob is transmitted to the cable drum located under the cockpit floor through chains, bevel gears and torque tubes. A cable from the cable drum, passing through the weight saving holes of the floor beams, reaches the hydraulic compartment, from which it runs through the fuselage to the rear side of the L.H. wing rear spar, transmitting the rotation of the control knob to the screw jack type trim actuator located at WS 10015. The trim actuator controls the trim tab, by pushing or pulling the trim control rod.

7.3.3 Indicator Box (See Fig. 7-9)

The trim control knob rotates from the 0 position to the left and to the right by 4.1 turns. Consequently, the reading of the indicator is reduced by the idler gear so that all the indication can be shown on the dial face.

The indicator scale has the following marking on it with 21 graduations:

Knob rotation	Indication	Tab position
Clockwise	Black	Up
Counter clockwise	Red	Down
0 position	Green	0

7.3.4 Procedures for Trim System Adjustment

(1) Neutral Fixed Points of the System (3 locations)

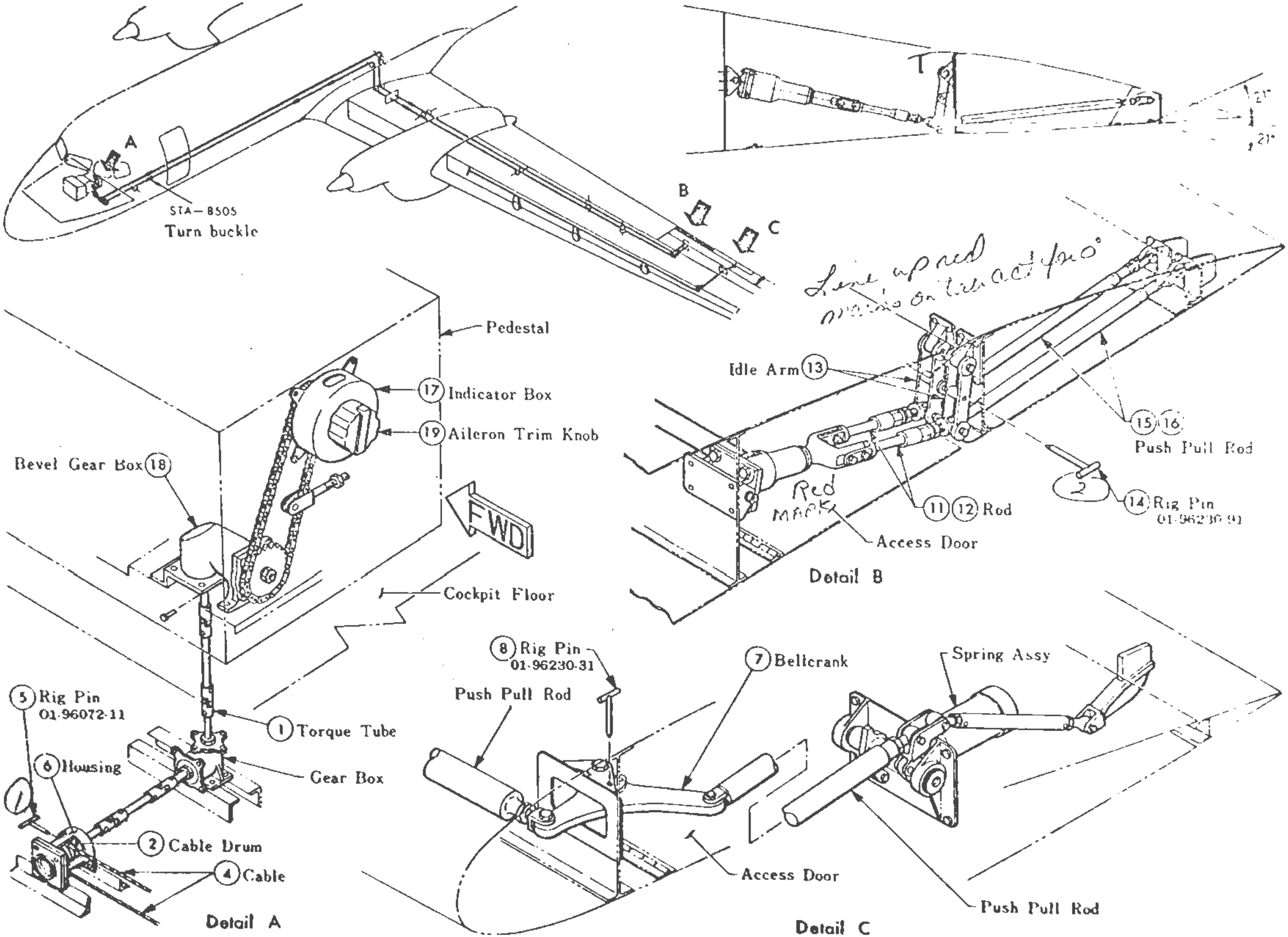
Number	Fixed to	Location	Fixing method
1	Cable drum	Cable drum	Rigging pin
2	Trim actuator	Acme screw shaft	Align the red mark.
3	Control rod	Idle arm	Rigging pin

(2) Procedures for adjustment

A. Fixing numbers 1 and 2, tighten the cable. The cable tension at 70°F is 30 ± 5 lb (±0.4 lb/°F).

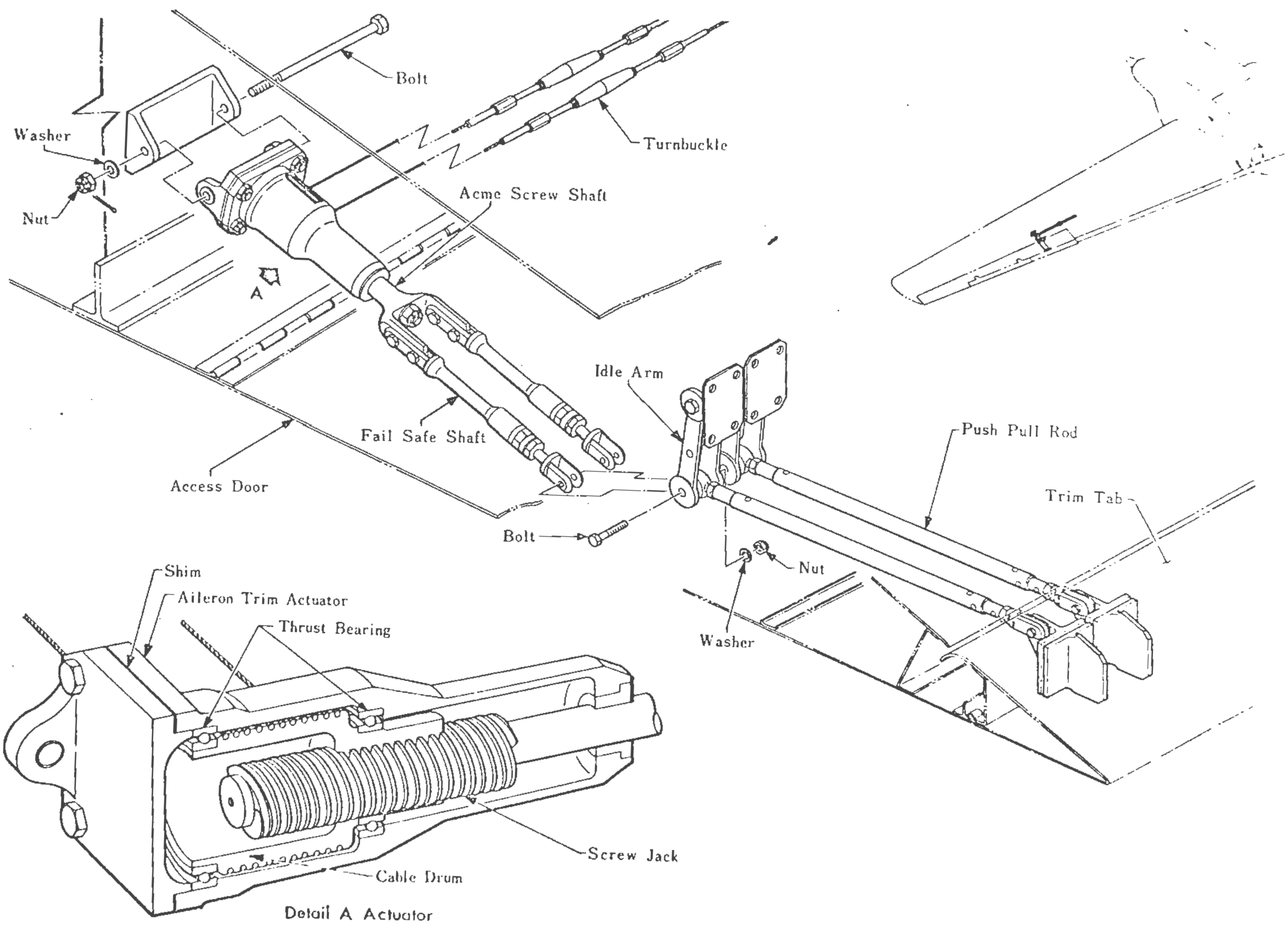
B. Fixing numbers 2 and 3, adjust the length of the control rod, setting the trim tab to 0° with a contour gauge.

C. The stopper for the trim system is contained in the indicator box. After 3 turns of the control knob, the stopper comes into action and no further movement can not be obtained.

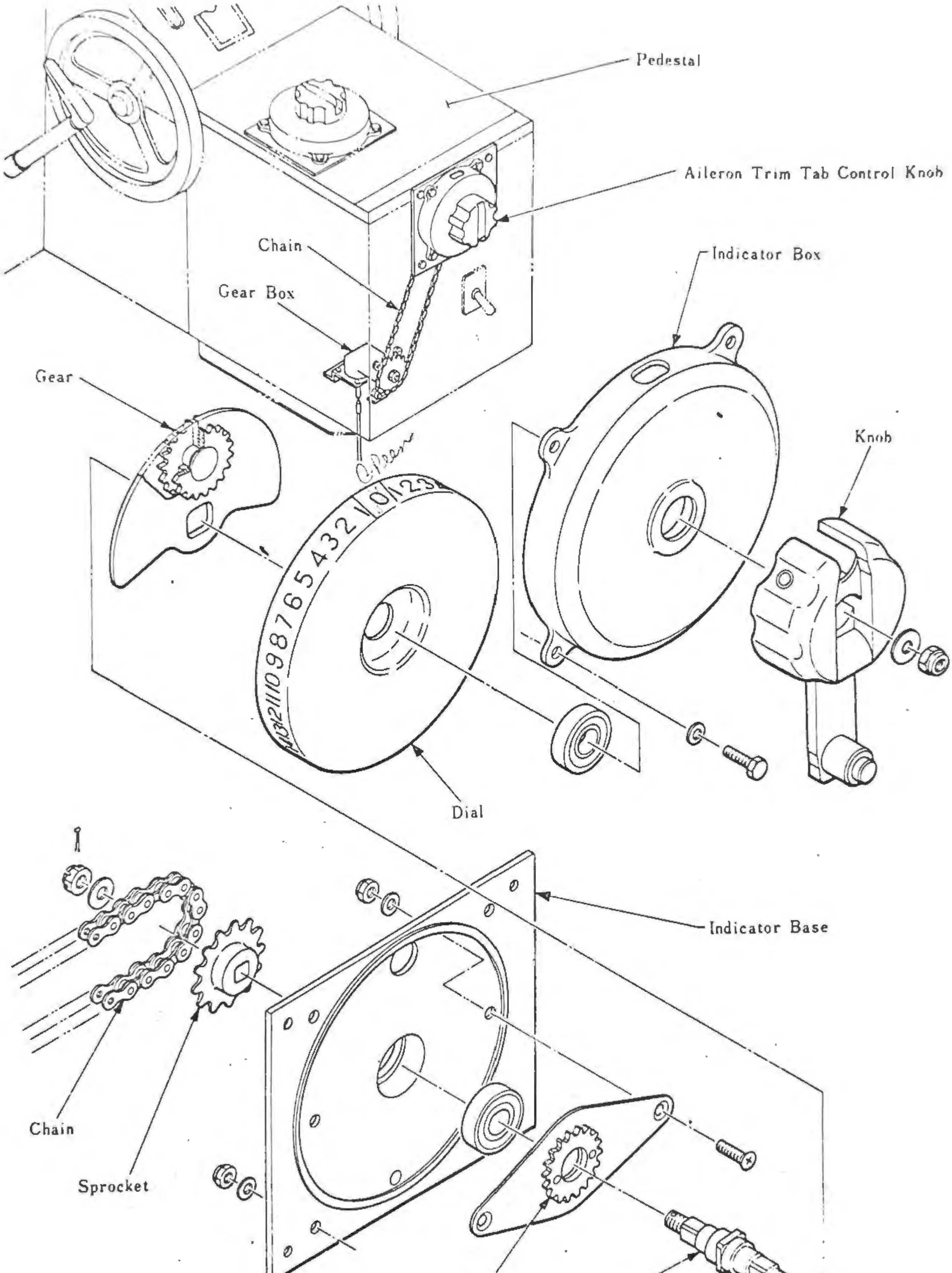


Aileron Trim Tab Control System Rigging

Figure 7-7



Aileron Trim Tab Actuator
Figure 7-8



Aileron Trim Indicator
Figure 7–9.

7.4 Rudder Control System

7.4.1 Attachment of Rudder (See Fig. 7-15)

The rudder is attached to the vertical stabilizer with three hinges. The weight of the rudder is supported by the lowest hinge.

7.4.2 Rudder Control System (See Fig. 7-10)

The rudder can be controlled by pushing the L.H. and R.H. pedals provided for the pilot and the co-pilot.
To each pedal is attached a rod which is connected to the forward quadrant (above the floor) in the cockpit. Quadrants are provided 1 ea. in front of the pilot seat and the co-pilot seat, both being connected with a beam and equalizing the movement of the rudder pedals for the pilot and the co-pilot.

On the rudder pedals for the pilot and the co-pilot are provided pedal adjust knobs with which the pedal positions can be adjusted, individually.

To each forward quadrant in the cockpit is attached a cable. This cable, passing through the weight saving holes on the floor beams below the floor, runs upwards by means of a pulley behind the pressure bulkhead at F.Sta +9035 and above the horizontal stabilizer, and it is connected to the quadrant with the tension regulator attached to the rudder torque tube (rudder lower assembly).

Pedal Adjust Mechanism (See Fig. 7-14)

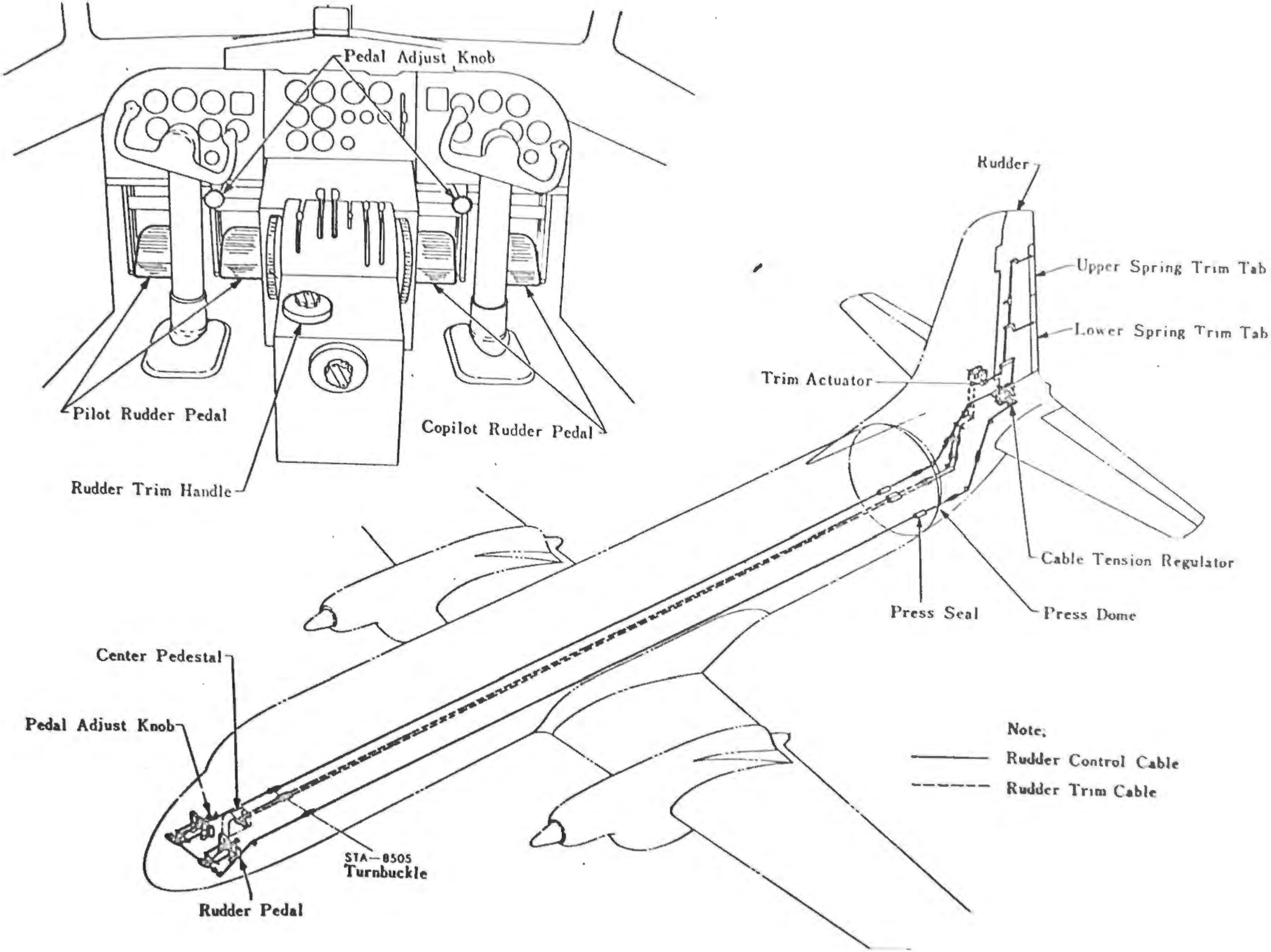
If the pedal is pushed, the force is transmitted to the arm, rotating the quadrant around its rotating axis through links and adjusters.
If the pedal adjust knob is rotated, its angle of rotation is transmitted to the screw. Since the screw does not move with respect to the quadrant, the adjuster moves fore and aft. This movement is converted into the rotation of the arm and, consequently, the rudder pedal can be moved fore and aft for adjustment without moving the quadrant.
The rudder pedal can be adjusted within 60.5 mm in the forward direction and 59.5 mm in the rearward direction.

7.4.3 Rudder Spring Tab Mechanism

The operating principle of the mechanism is the same as that for the aileron. The rudder spring tab mechanism consists of the lower assembly and the upper assembly.

(1) Lower Assembly (See Fig. 7-14)

On the lower part of the rudder is provided a torque tube 80 mm in the rear of the rudder hinge line. The control force is transmitted to this torque tube to rotate it. On this torque tube is installed the spring tab mechanism. On a plane perpendicular to the rudder hinge line are provided in parallel each other 2 sets of triangular plates, each set consisting two plates and these sets of the plates can rotate around the rudder hinge line freely.



Rudder and Tab System
Figure 7-10

One set of the plates (A set) is fixed on the rudder torque tube (on the uppermost part and the lowest part), rotating around the hinge line together with the rudder. Therefore, it is considered to be a part of the rudder torque tube. On the other set of the plates (B set) is built the quadrant with a tension regulator. This set can rotate around the rudder hinge line freely, moving in relation to the plates of the A set.

The B set is attached to the plates of the A set with long bolts around which the plates of the B set can rotate freely.

With respect to the upper and lower plates in two sets one end of each plate other than the hinge line is installed with a long bolt and the spring of the spring tab mechanism is installed between those bolts.

To the plates of the B set are connected to the tab actuating link mechanism, transmitting the deflection of the spring to the upper assembly to actuate it.

(2) Upper Assembly (See Figs. 7-12 and 7-14)

In the rudder is provided the link mechanism for the spring tab control rod. This link mechanism is connected to the rudder trim control mechanism at V.Sta 430. The tab consists of the upper tab and the lower one, both moving in the same fashion.

(3) Operation (See Fig. 7-11)

The bottom end of the rod X is connected to the tension regulator of the lower assembly, the upper end of the rod Y to the bellcrank at V.Sta 1355 and the left end of the rod Z to the trim actuator.

a. When spring tab only is operated without operating trim.

Rotate the arm of the spring tab around the hinge point β and transmit the deflection of the spring to the rod Y.

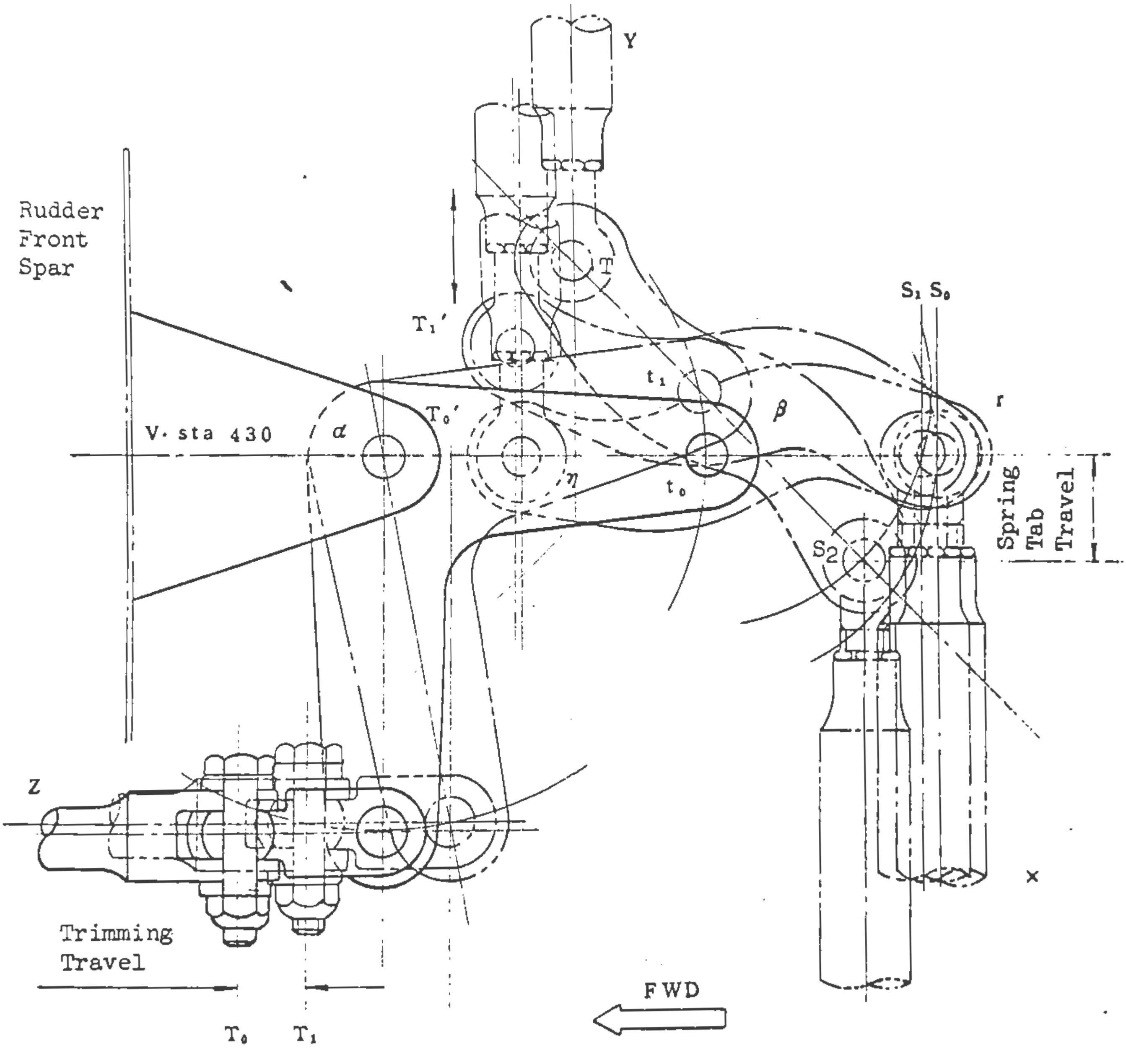
b. When trim only is operated without operating spring tab.

The trim control rod moves from T_0 to T_1 and the bellcrank rotates around a point α. As a result, the point β of the arm moves from t_0 to t_1. As the rod X can not actuate the spring of the spring tab since the bottom end of the rod X is connected to the tension regulator, the point γ moves from S_0 to S_1 horizontally. The point η moves from T_0' to T_1', actuating the tab.

c. When spring tab is operated under the above conditions a and b.

The point γ moves from S_1 to S_2.
The point β remains standstill at t_1.
The point η moves from T_1' to T.

The total movement of the tab amounts to the sum of ($T_0' \rightarrow T_1'$) and ($T_1' \rightarrow T$).



Link Mechanism at V.Sta 430

Figure 7-11

7.4.4 Rudder Cable Tension Regulator (See Figs. 7-12 and -13)

The cable tension regulator is installed on the lower part of the torque tube of the rudder assembly together with the rudder spring tab control mechanism.

The regulator consists of the sector which can rotate around the rudder hinge line freely, spring with which the control cable tension is adjusted, rod which connects the sector and the spring with the regulator shaft and support. With respect to the hinge line, the cable is balanced at a specified position by moment of the spring force and cable tension.

If the cable and the airframe expand or contract as the temperature changes, the tension of the two cables change by an equal amount. As a result, two sectors rotate at a new position corresponding to the spring force, maintaining the cable tension at a constant value.

The moment change to the hinge line of the two sectors has the same absolute value with opposite directions, being balanced as a whole and it does not rotate the rudder. While the aircraft is being controlled, the moment of the sector is uneven and unbalanced and the sectors rotate around the rudder hinge line, permitting the rudder control.
The tension regulator is provided the compensation scale, showing the tensile strength of the rudder cable.

7.4.5 Stopper and Functions of Rudder Control System. (Fig. 7-14)

The stoppers of the rudder control consists of three

(1) Rudder Stopper

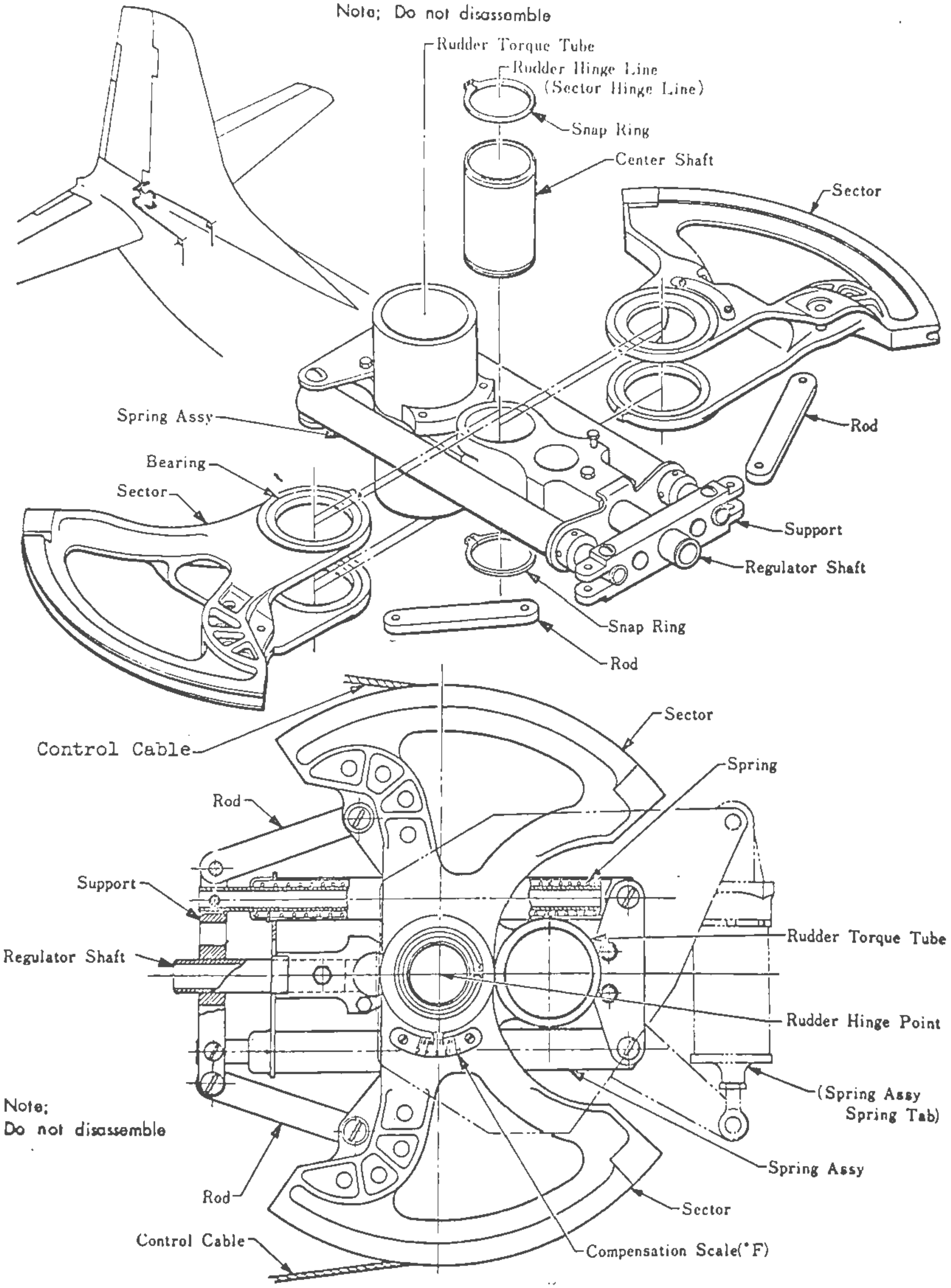
(2) Spring Tab Stopper

(3) Quadrant Stopper in the forward part in the cockpit.

(1) has a stopper arm on the torque tube of the rudder lower part and the stop bolt is located in the rear of the vertical stabilizer. It restricts the rudder angle.

(2) has a spring tab stopper on the lower assembly of the tab mechanism. It restricts the angle of control surface.

(3) has a stopper of the forward quadrant in the forward quadrant. This protects the system so that excessive load can not be applied to the system.



Note; Do not disassemble

Note;
Do not disassemble

Rudder Control Cable Tension Regulator

Figure 7–12

7.4.6 Procedures for System Adjustment (See Fig. 7-14)

(1) Neutral fixed points of the System (6 locations)

Number	Fixed to	Location	Fixing Method
1	Rudder pedal	Pedal arm	Rigging pin
2	Forward quadrant	Quadrant	Rigging pin
3	Quadrant with tension regulator	Rudder	Gust lock "ON"
4	Bellcrank	V.S. 430	Rigging pin
5	"	V.S. 1280	"
6	"	V.S. 3030	"

(2) Adjusting Procedures

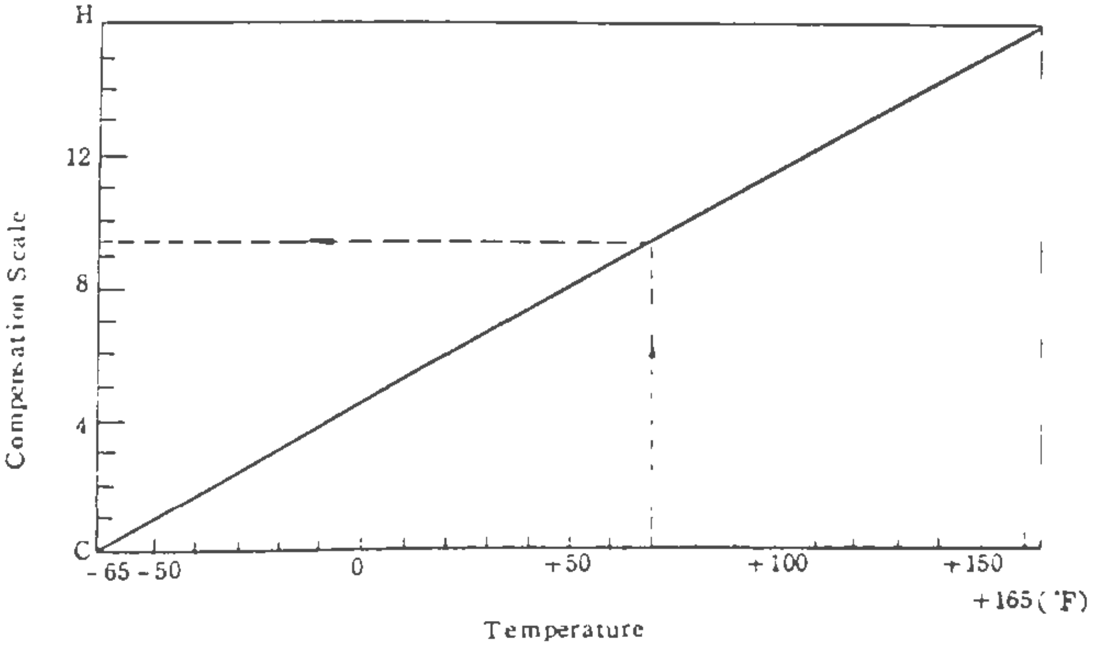
On Fuselage Side

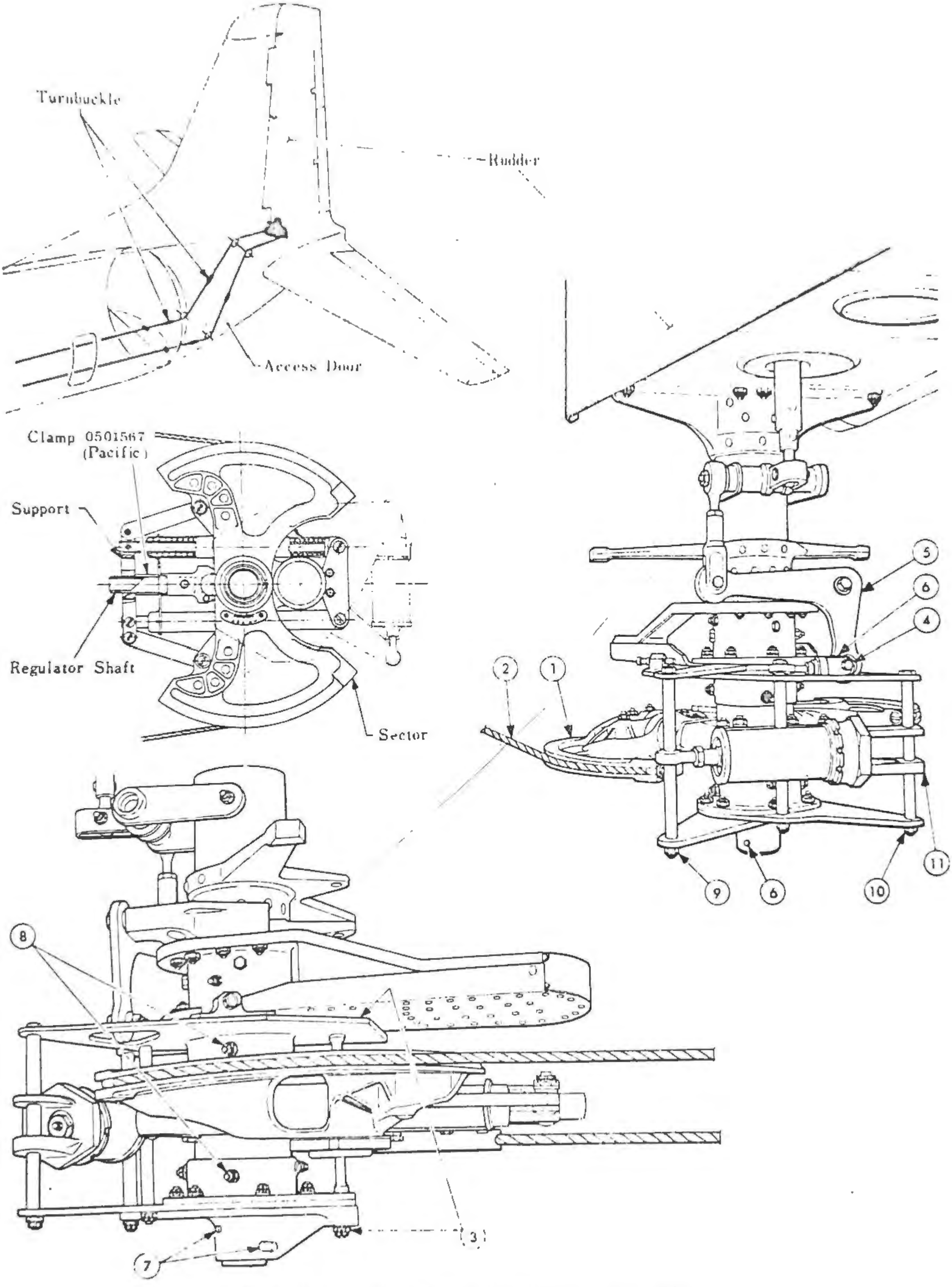
A. Fix number 3 and

B. Fix number 2 and tighten the cable.

C. Fixing number 1, adjust the length of the pedal arm and adjust the length of the pedal adjusting mechanism and the rod.

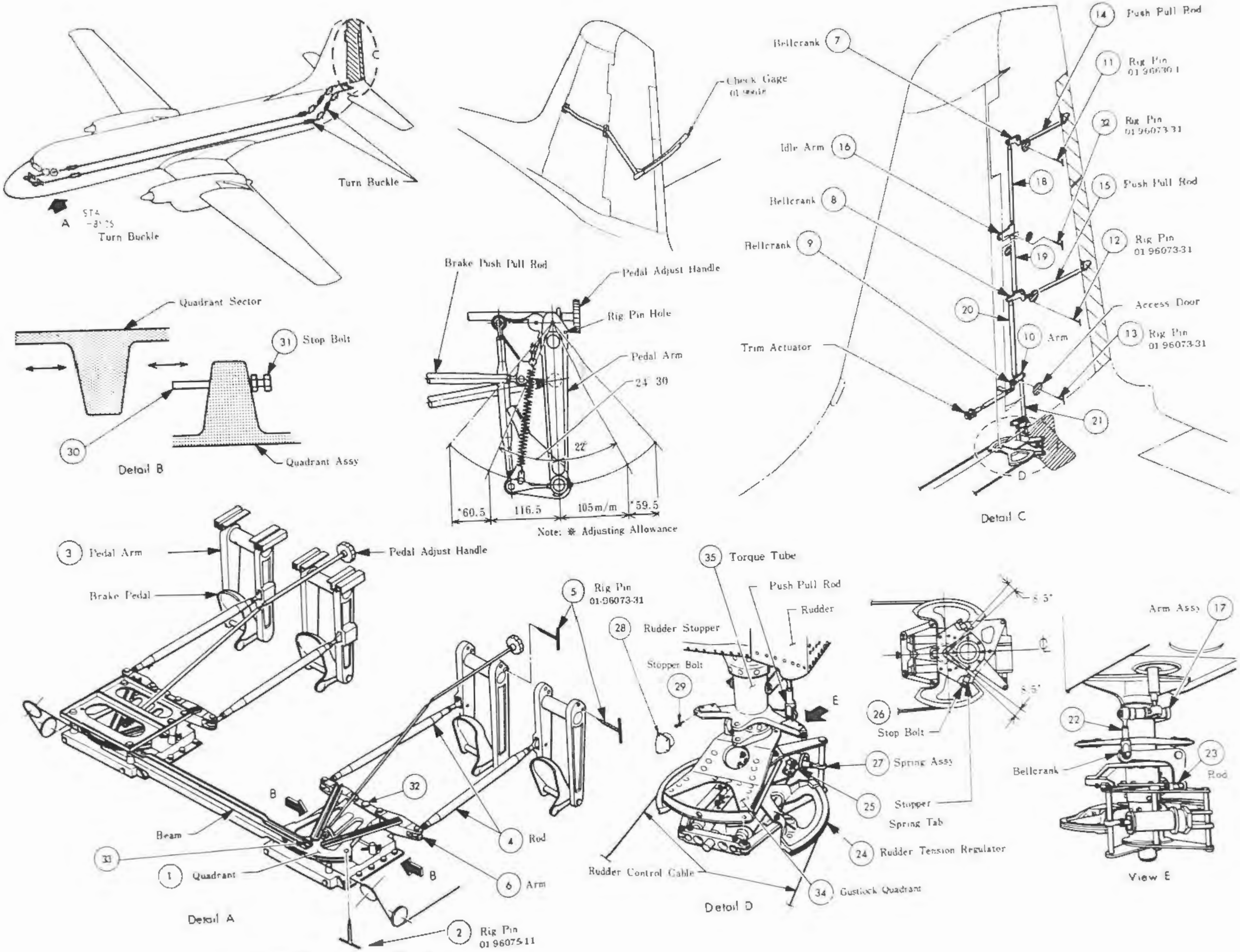
Tighten the cable in accordance with the graph of the following compensation scale:





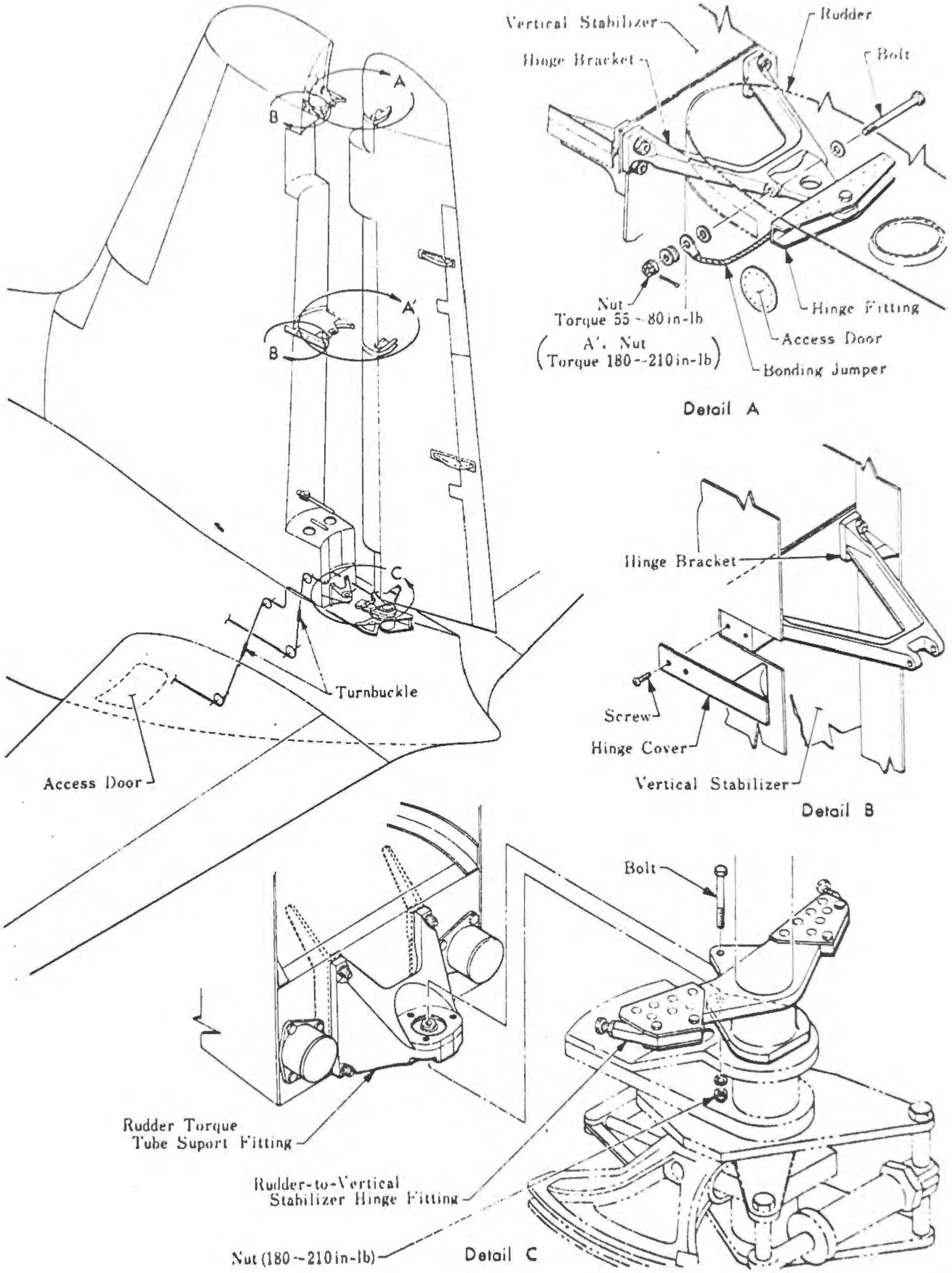
Rudder Control Cable Tension Regulator Remove Installation

Figure 7-43



Rudder Control System Rigging

Figure 7-14



Detail A

Detail B

Detail C

Rudder Hinge

Figure 7-15.

Rudder Side

D. Fixing numbers 3 to 6, adjust the spring tab. This is accomplished by setting the rudder and the spring tab to 0° with the angle gauge and adjust the length of each rod.

Adjustment of Each Stopper

E. Depress the rudder pedal and adjust the spring tab stopper so that the rudder travel angle measured by the angle gauge is within the specified limits.

F. Adjust the rudder stop bolt so that the specified angle is attained when the rudder pedal is depressed further.

G. Adjust the stop bolt of the forward quadrant stopper in the cockpit so that the quadrant comes in contact with the stopper when 82 kg ± 2 Kg weight is placed on the rudder pedal after the stoppers mentioned in E and F come into action.

7.5 Rudder Trim Tab Control System

7.5.1 Attachment of Spring and Trim Tab (See Fig. 7-16)

The spring tab and the trim tab are controlled by a control mechanism, being divided into two tabs, upper tab and lower one. The upper tab and the lower tab are attached to the rudder tab hinge fittings with two hinge bearings and three, respectively.

7.5.2 Rudder Trim Tab Control System (See Fig. 7-17)

The rudder trim tab can be controlled by rotating the rudder trim tab control knob on the center pedestal in the cockpit. The rotation of the control knob is transmitted to the cable drum below the cockpit floor through the torque tubes and bevel gears. A cable from the cable drum passes the weight reducing holes of the floor beams, bends up at the pulley at FUS. Sta + 9484 behind the pressure bulkhead and transmits the rotation of the control knob to the screw jack type trim actuator located at V.Sta 345 in the vertical stabilizer. A push-pull rod connected to the trim actuator, in turn, controls the tab.
On the pedestal is provided the indicator box, indicating the amount of the rudder trim control (trim tab angle).

7.5.3 Indicator Box (See Fig. 7-19)

The rotation of the trim control knob which rotates to the left and to the right by 4.3 turns, respectively, is reduced by the reduction gears and its indication is shown on the dial of the indicator with graduations on the entire face.

Graduations of Indicatior

Rotation of Knob	Indication	Tab Position
Clockwise	Black	Left
Counterclockwise	Red	Right
0	Green	0

15 graduations are marked on both L.H. and R.H. sides.

7.5.4 Procedures for Trim Tab System Adjustment (See Fig. 7-17)

(1) Neutral fixed points of System (3 locations)

Number	Fixed to	Location	Fixing Method
1	Cable drum	Cable drum	Rigging pin
2	Trim actuator	Vertical stabilizer at V.Sta 380	Rigging pin
3	Push-pull rod	V.430, Bellcrank	Rigging pin

(2) Adjusting Procedures

A. Place the rudder in the neutral position (gust lock "ON").

B. Fix number 1.

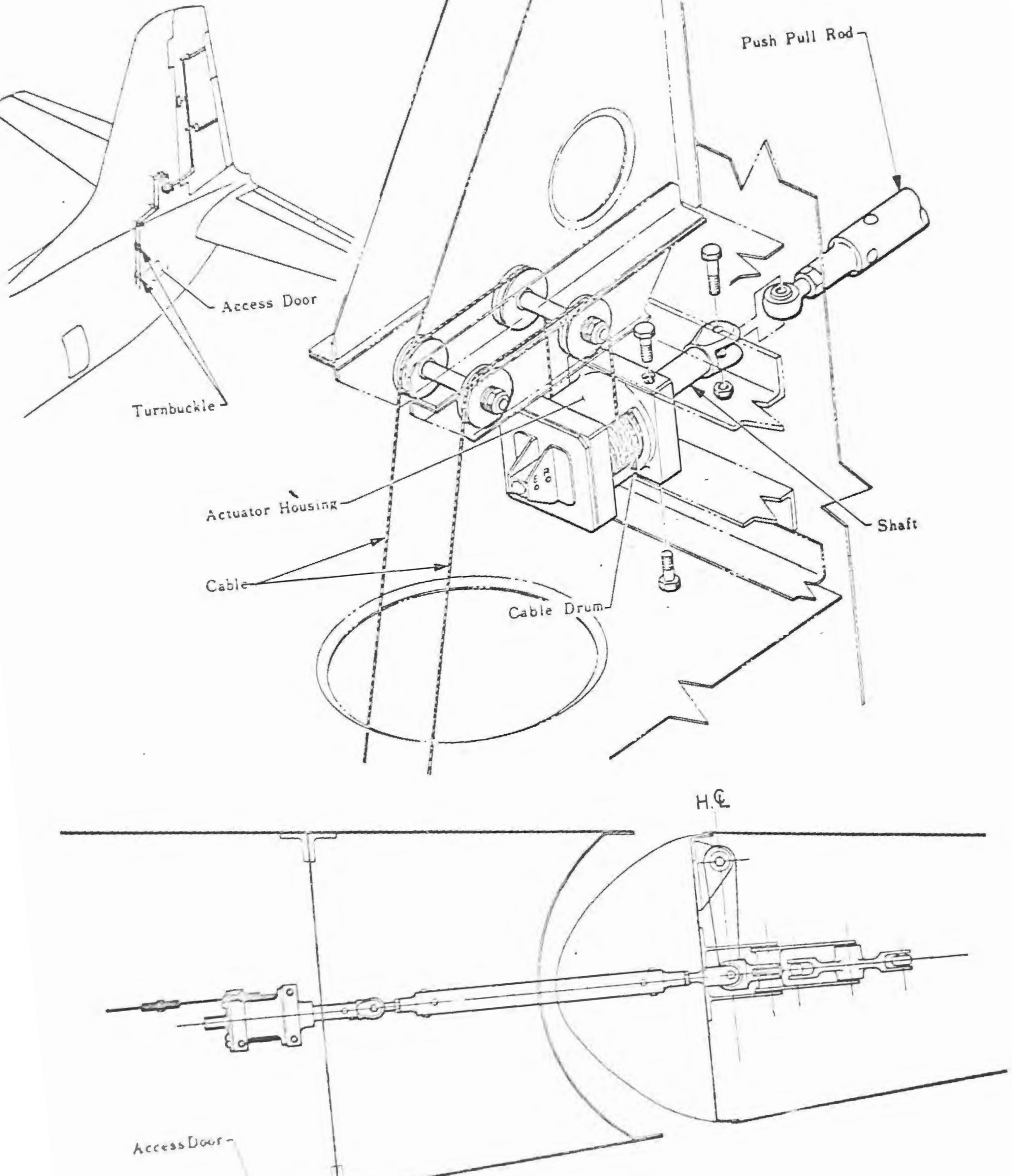
C. Fix number 2.

D. Tighten the cable. The cable tension should be 30 ± 5 lb (±0.4 lb/°F) at 70°F.

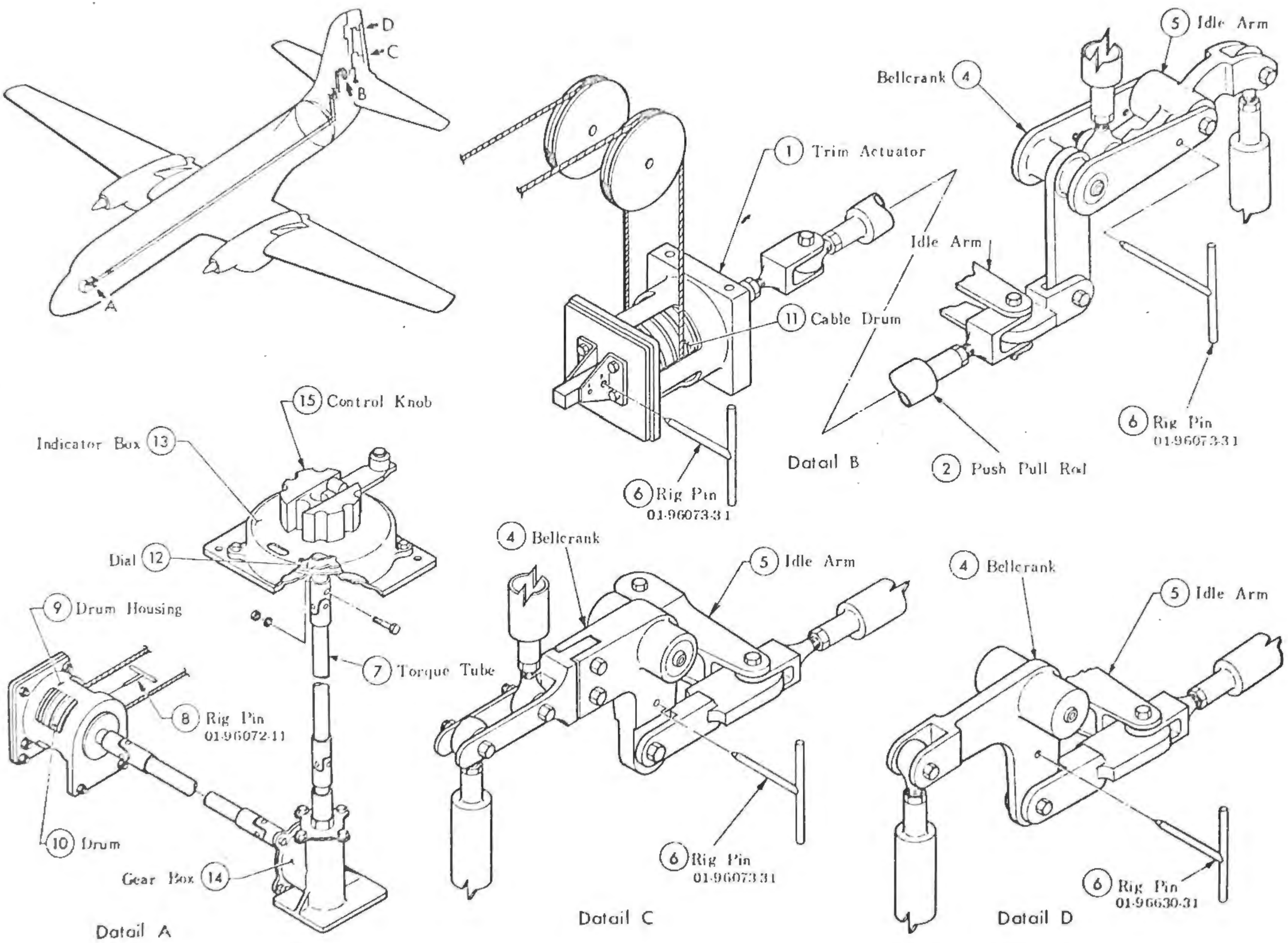
E. Fix numbers 2 and 3. Adjust the length of the push-pull rod if adjustment of the spring tab has been completed.

Adjustment of Stopper

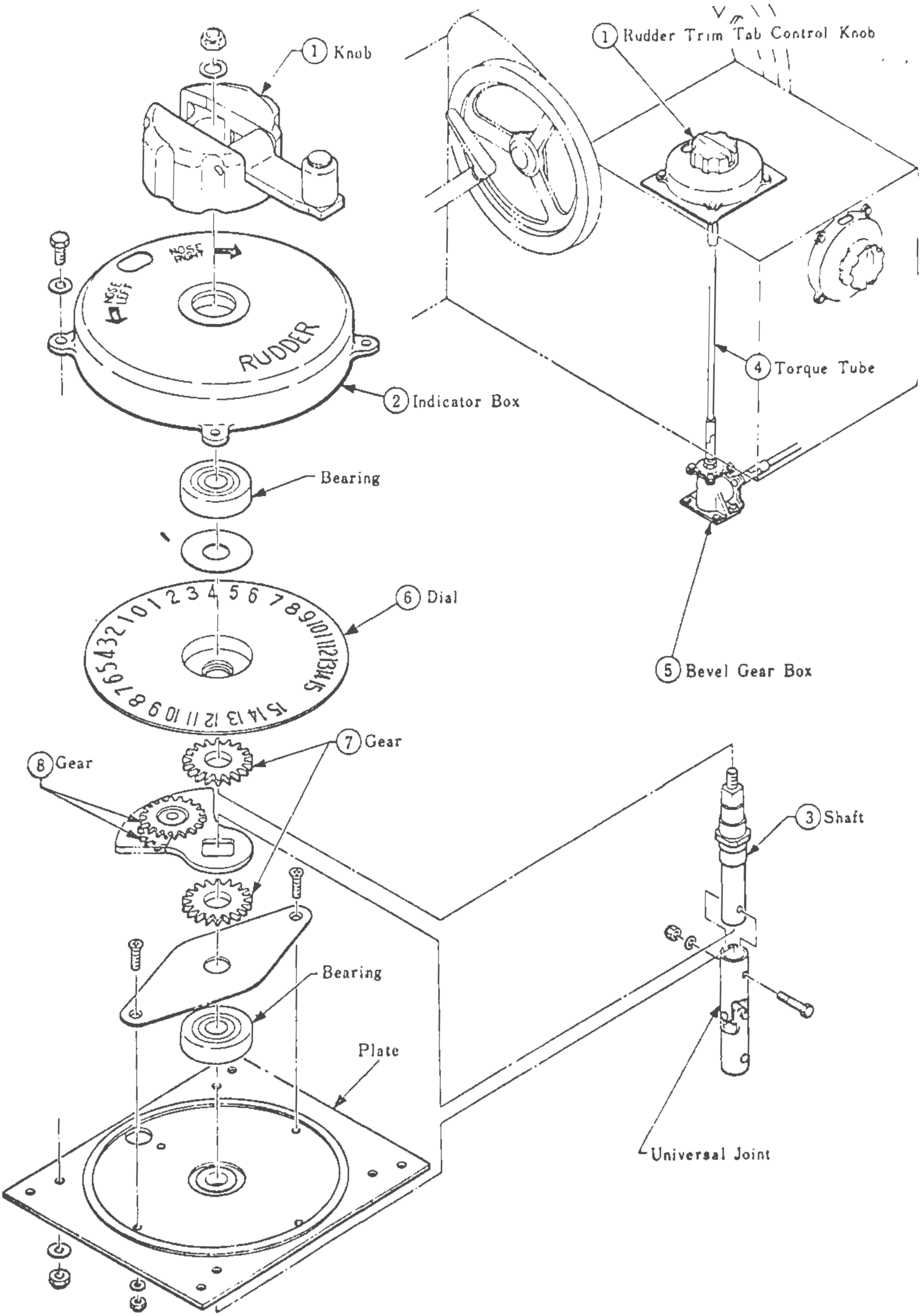
F. The stopper for the trim system is built in the indicator box. If the control knob is rotated to the full, the stopper comes into action and no further movement is possible.



Rudder Trim Tab Actuator
Figure 7-18



Ruder Trim Tab Rigging
Figure 7-17



Rudder Trim Tab Indicator
Figure 7–19

7.6.6 Procedures for Balance Tab System Adjustment (See Fig. 7-28)

(1) Neutral fixed points of system (3 locations)

Number	Fixed to	Location	Fixing method
1	Control column	Control column	Rigging tool
2	Quadrant with tension regulator	Quadrant	Match the arm mark.
3	Elevator	Torque tube	Gust lock "ON"

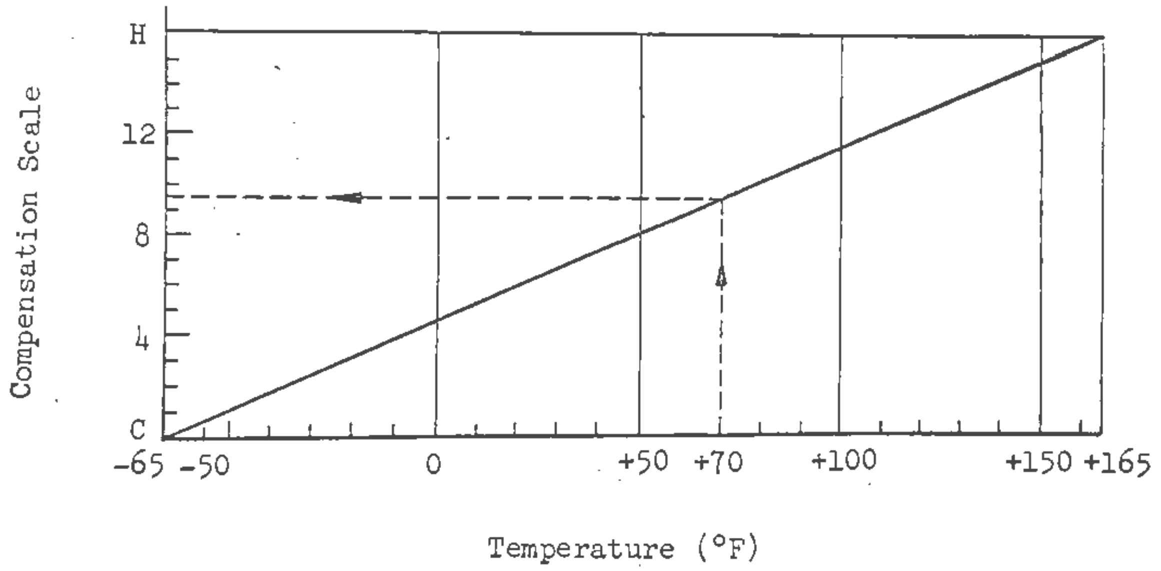
(2) Adjusting procedures

A. Fix number 1.

B. Fix number 3.

C. Adjust the push-pull rod so that the arm mark of the quadrant with a tension regulator, number 2, is lined up to the mark on the frame at Fus. Sta. 10585.

D. Tighten the cable. For the tension, see the compensation scale for the regulator.

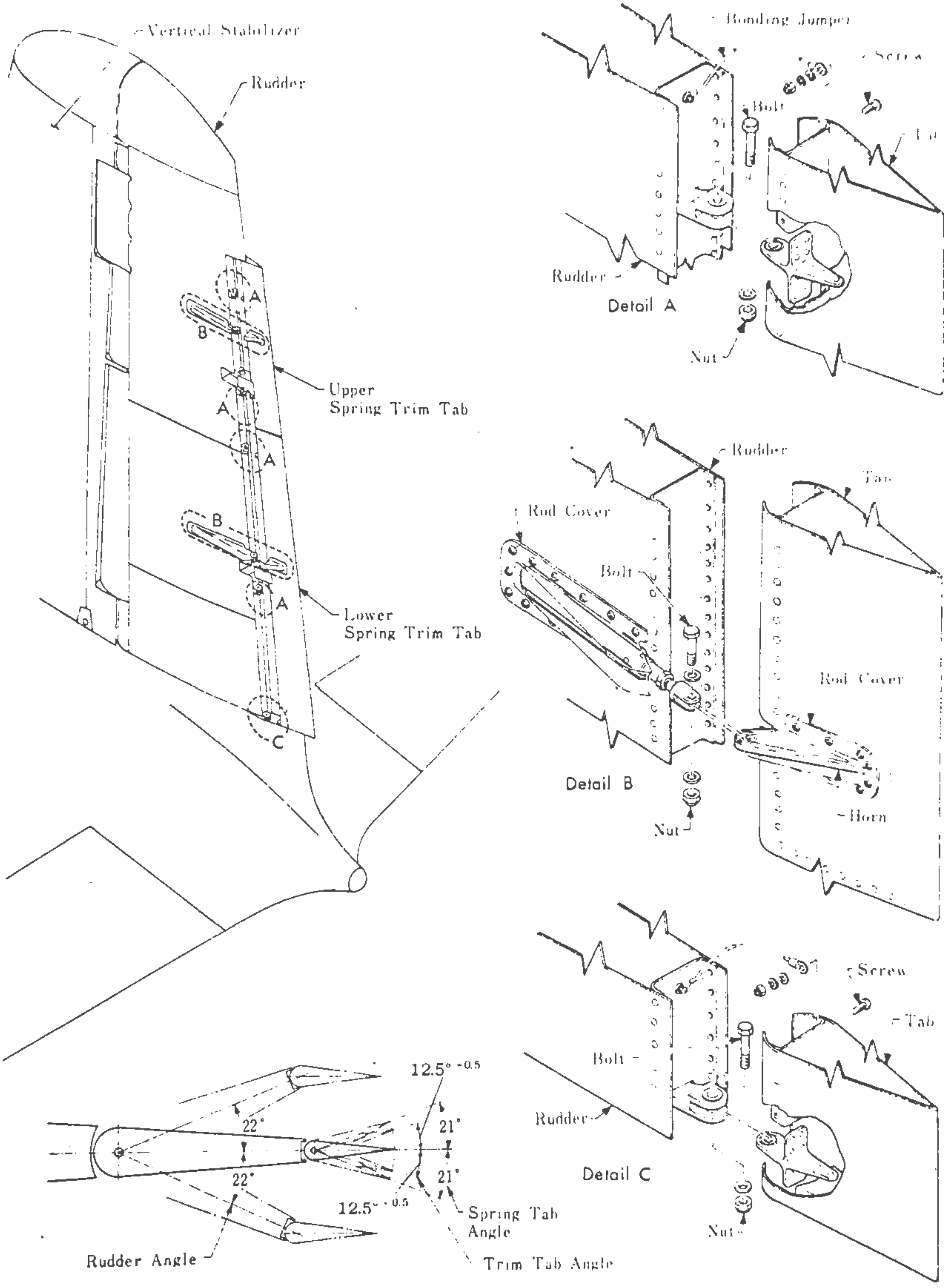


E. Fix the control surface at its neutral position with number 3 and adjust the tab, setting the tab to 0° with a contour gauge.

Adjustment of Stopper

F. Adjust the stop bolt for the elevator using a contour gauge so that the elevator can be controlled within the specified angle range.

G. Adjust the stop bolt for the control column so that the column comes in contact with the stopper when 55 Kg ± 1 Kg force is applied to the column center after the stopper mentioned in F comes in contact.



Rudder Spring Trim Tab Hinge

Figure 7–16

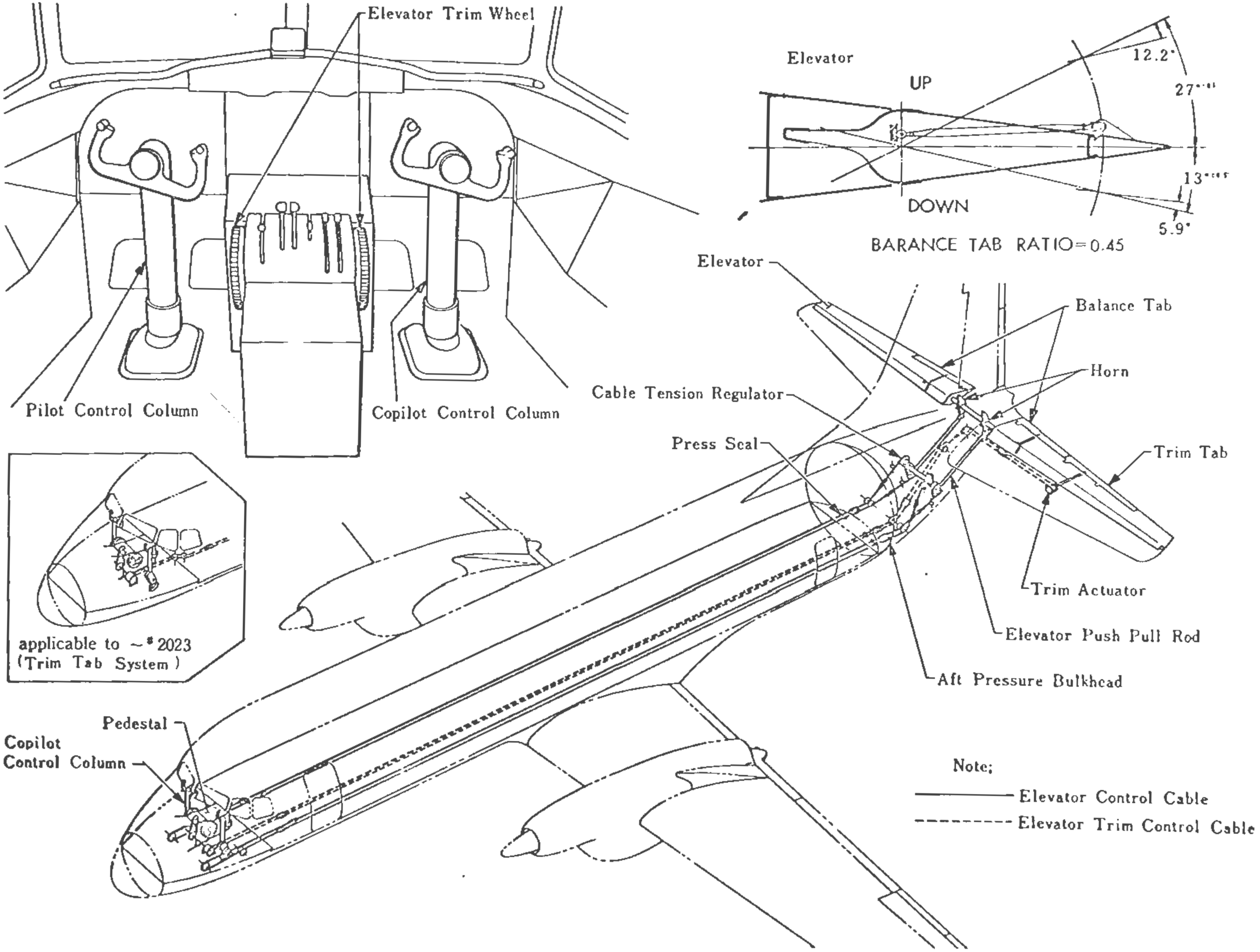
7.6 Elevator Control System

7.6.1 Attachment of Elevator (See Fig. 7-22)

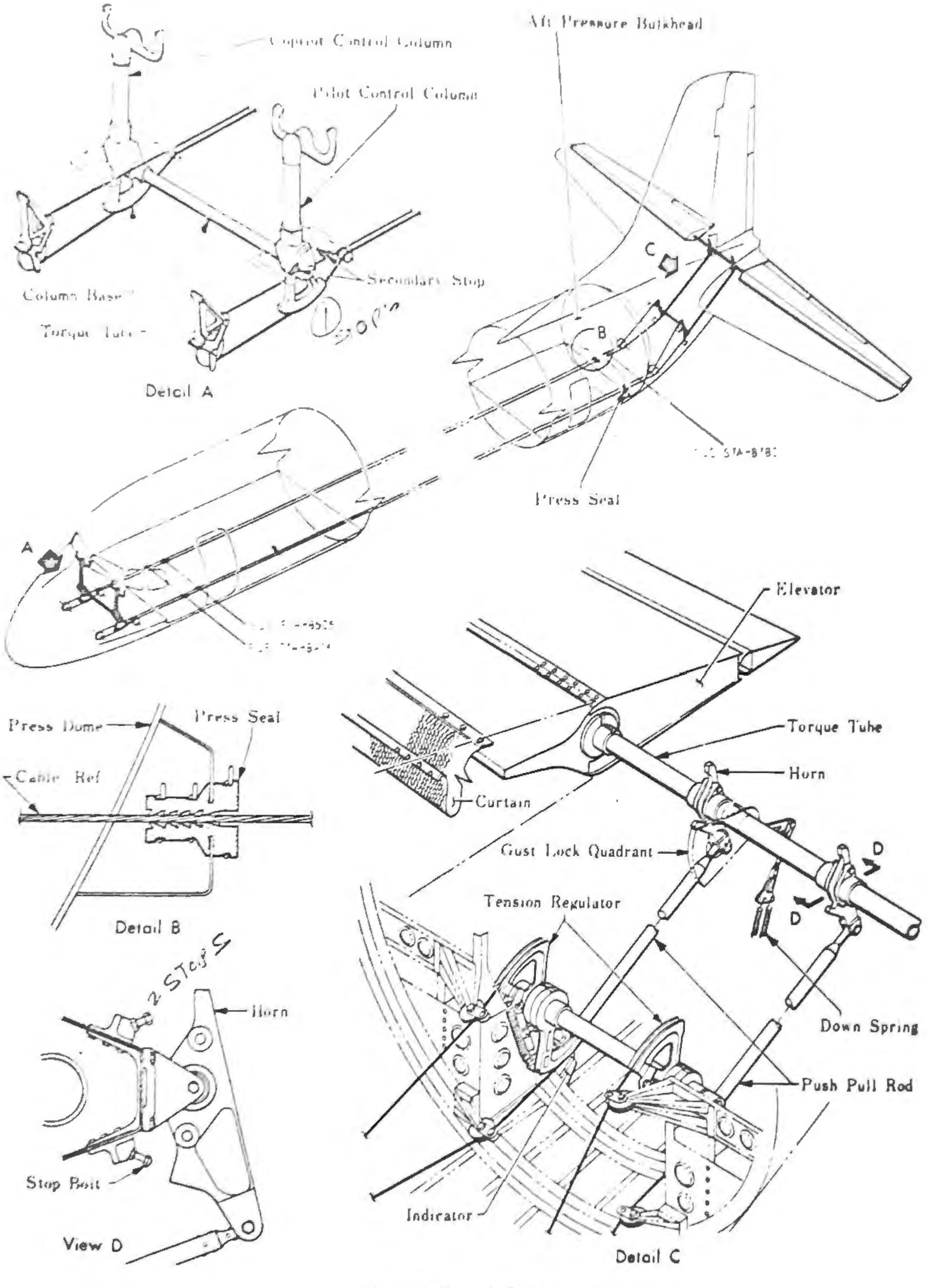
The elevator is attached to the support fittings on the rear spar of the horizontal stabilizer with self aligning roller bearings of 4 hinges. The L.H. and R.H. elevators are connected together with a torque tube.

7.6.2 Elevator Control System (See Figs. 7-20 and 7-21)

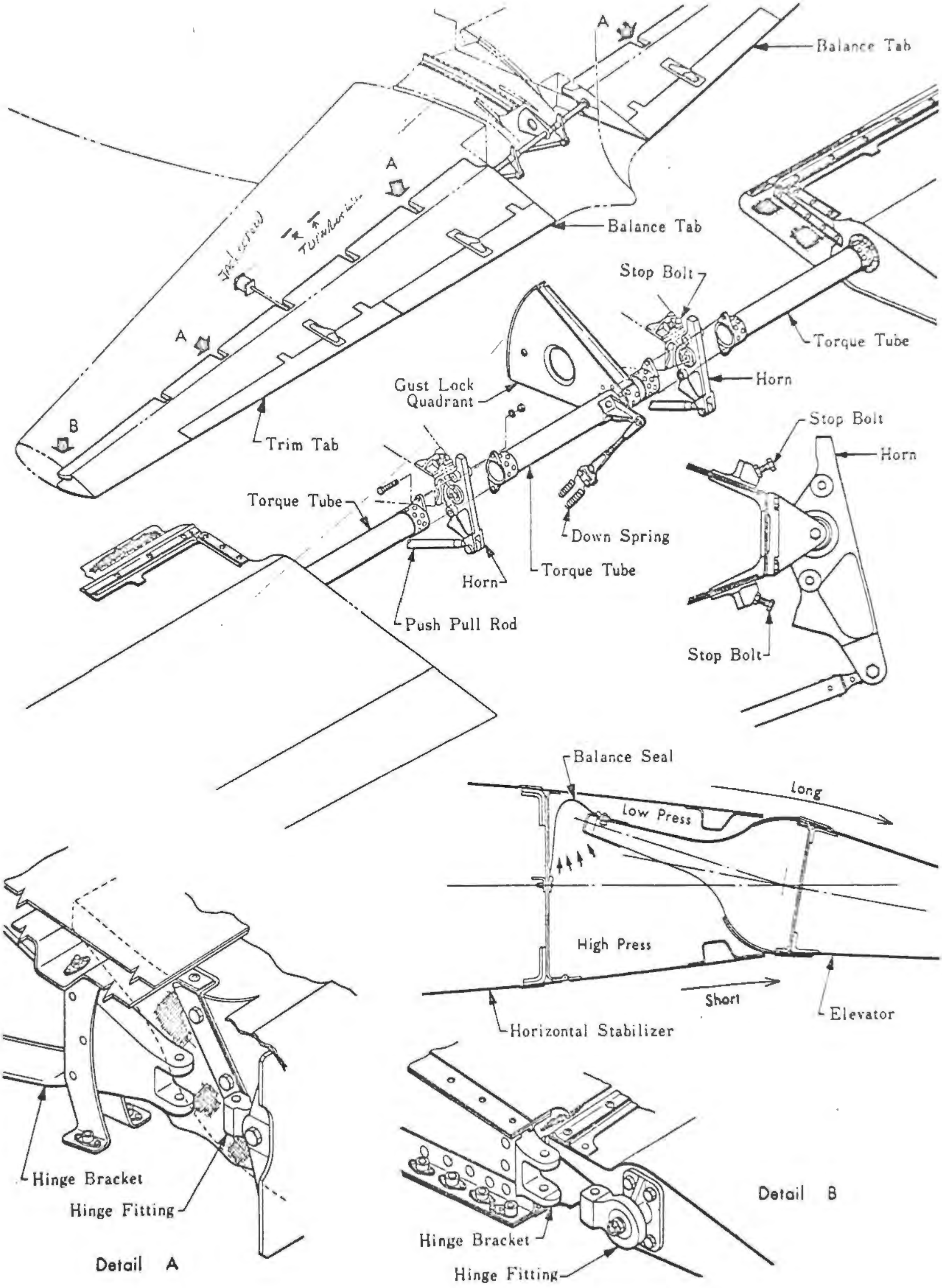
The elevator can be controlled by pushing or pulling the control column in the cockpit. The control columns for the pilot and co-pilot are connected together under the floor with a torque tube and on the root of each column is attached a quadrant. A cable from the quadrant passes the weight reducing holes of the floor beams and is connected to the quadrant with a tension regulator at Fus. Sta 10585 in the aft fuselage through pulleys. Quadrants with tension regulators are provided 1 ea. (2 in all) on the L.H. and R.H. sides, connected together with a torque tube. The arms on the L.H. and R.H. quadrants and the horn fittings on the torque tube which connects the L.H. and R.H. elevators are connected with push-pull rods through which the control signals from the cockpit are transmitted to the elevators.
On the elevator torque tube is installed the down spring.



Elevator and Tab System
Figure 7-20



Elevator Control System
Figure 7-21



Elevator
Figure 7-22

7.6.3 Elevator Cable Tension Regulator (See Figs. 7-23 and 7-24)

Its structure is somewhat different from that of rudder control system but it works on the same principle.

In the regulator unit are provided the rotating shaft and brake. The rotating shaft has a disc in its center and threads on both ends, opposite in direction each other.

Retention of Control Cable Tension

When an equal force is applied to the quadrant, the rotating bolt is rotated and the quadrant rotates and moves, but the torque tube does not rotate.

Elevator Control

If a one sided force is applied to the quadrant, the center disc comes in close contact with the brake, not rotating, and, consequently, the torque tube is rotated through the regulator unit shaft.

7.6.4 Elevator Balance Tab (See Figs. 7-25 and 7-26)

The balance tab is attached to the trailing edge of the elevator with three hinges. The push-pull rod for the balance tab mechanism is connected to the tab horn fitting at H.Sta 1400 and the bracket of the elevator hinge fitting.

If the elevator is controlled, the balance tab is moved against the direction of the elevator by the rod.

7.6.5 Stoppers of System and Functions (See Fig. 7-28)

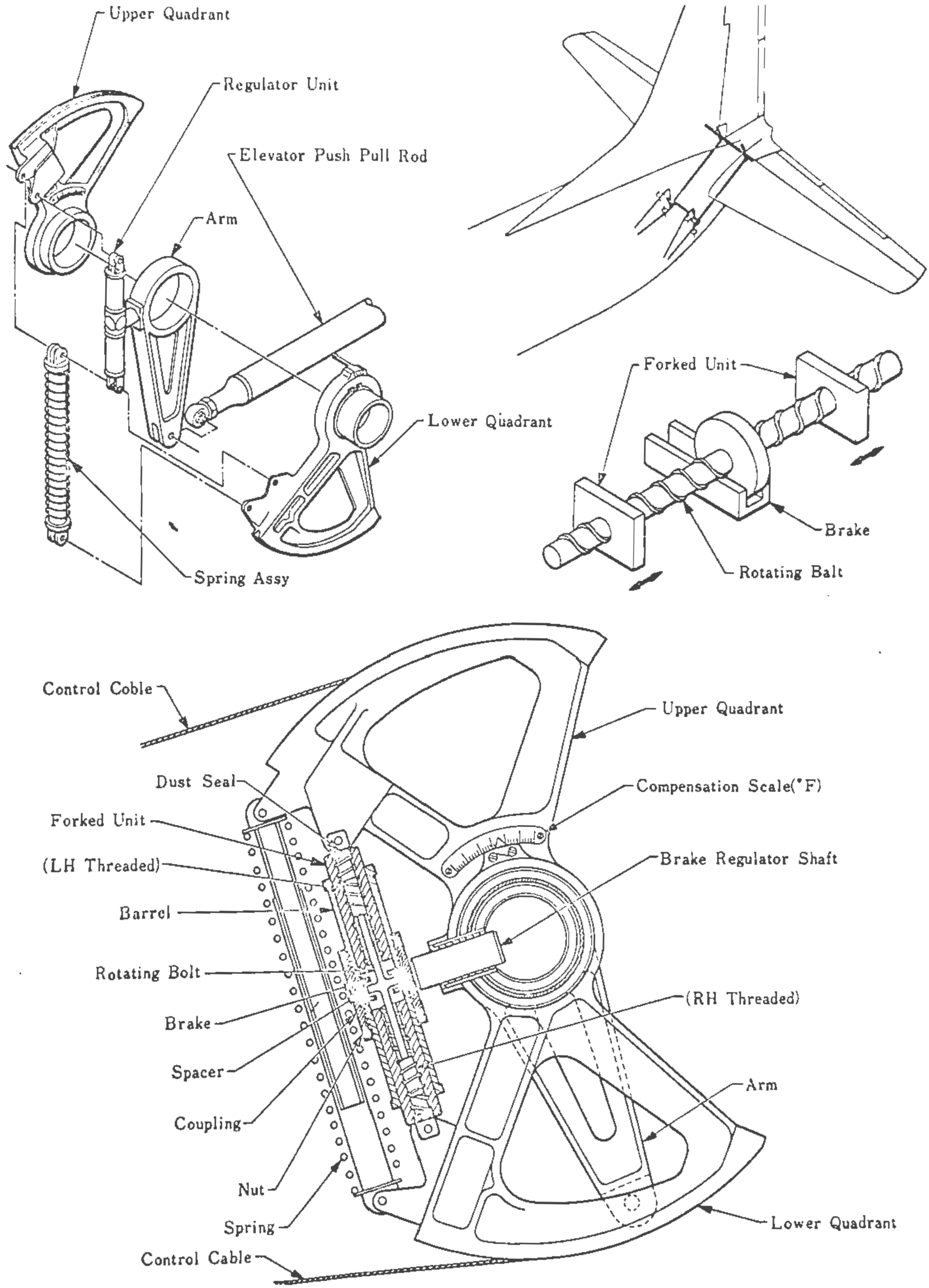
Two stoppers are provided for the elevator control system.

(1) Elevator stopper

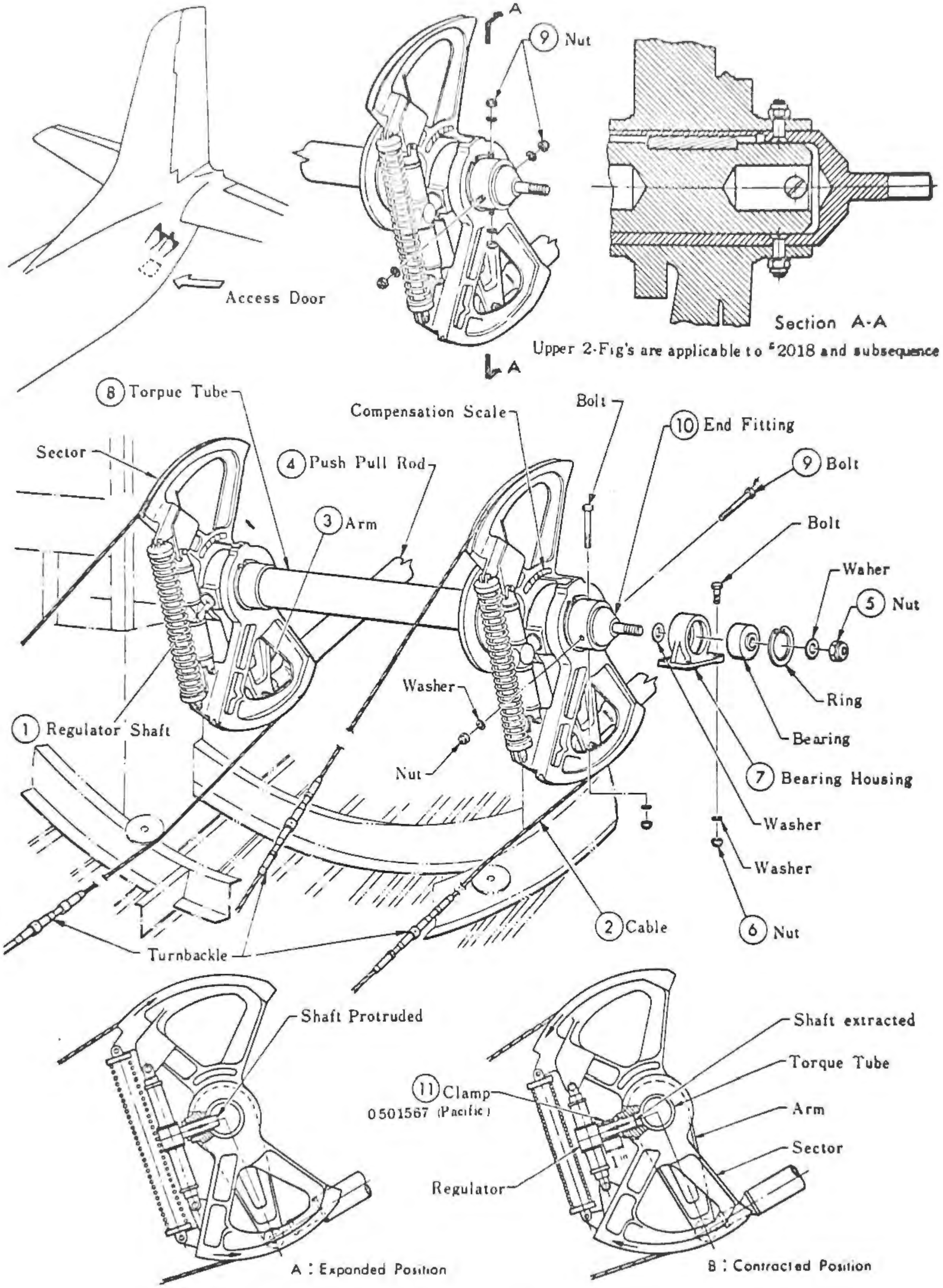
(2) Control column stopper

(1) has an elevator stop bolt on the trailing edge of the horizontal stabilizer with which the horn fitting comes in contact. This restricts the elevator travel angle.

(2) is located on the lower part (above the floor) of the control column to protect the system.

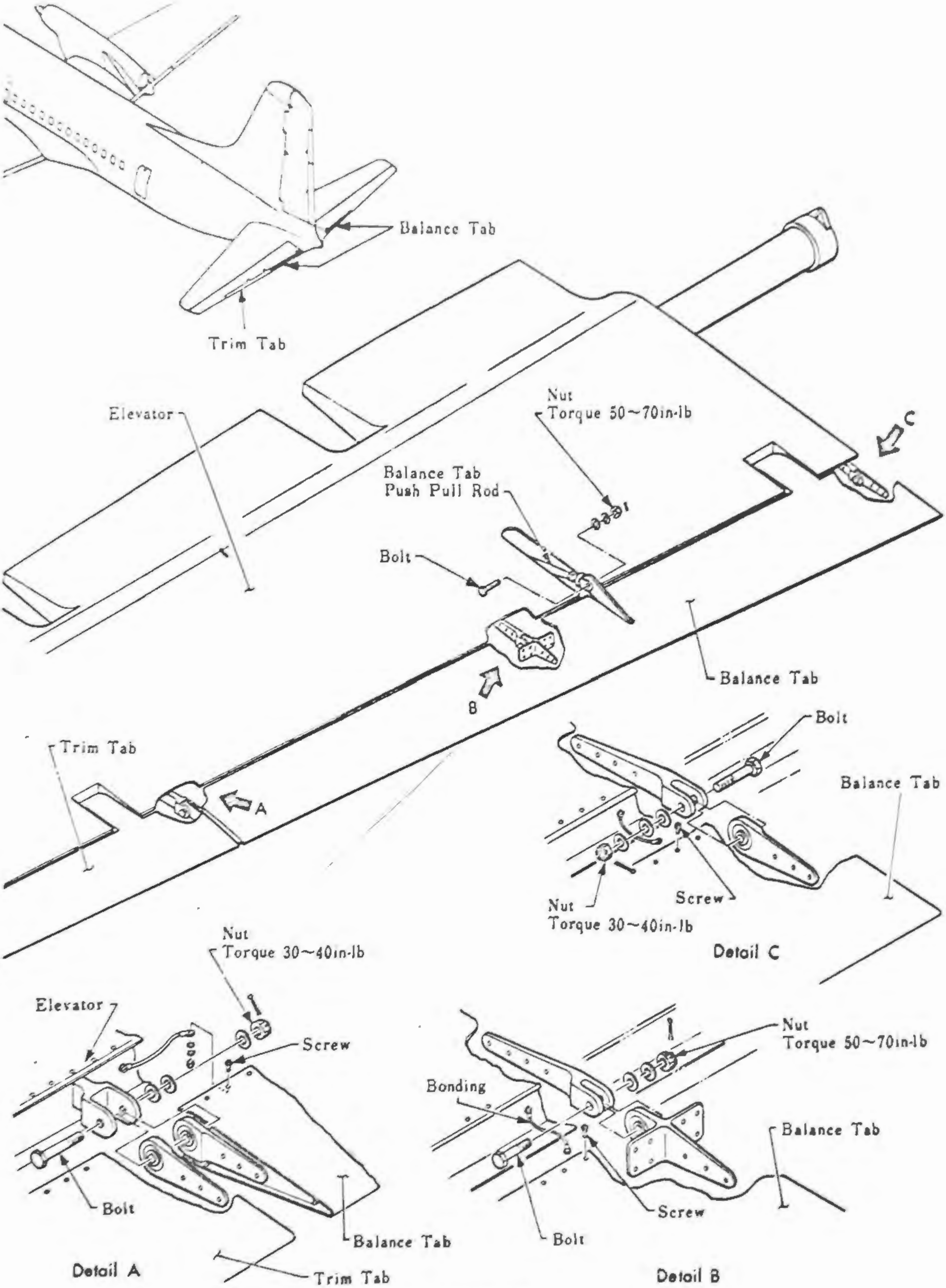


Elevator Control Cable Tension Regulator
Figure 7-23



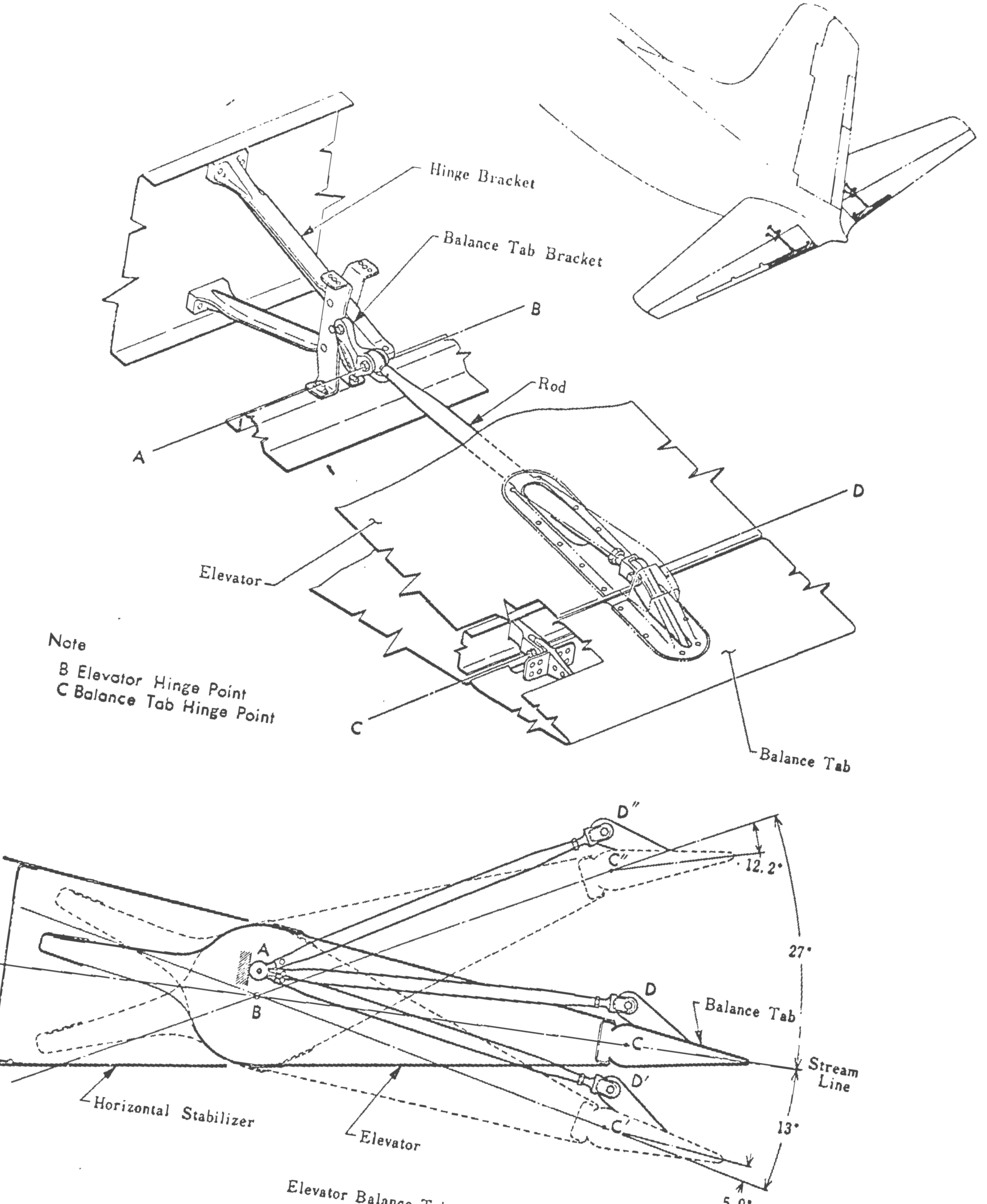
Elevator Tension Regulator Remove Installation

Figure 7-24



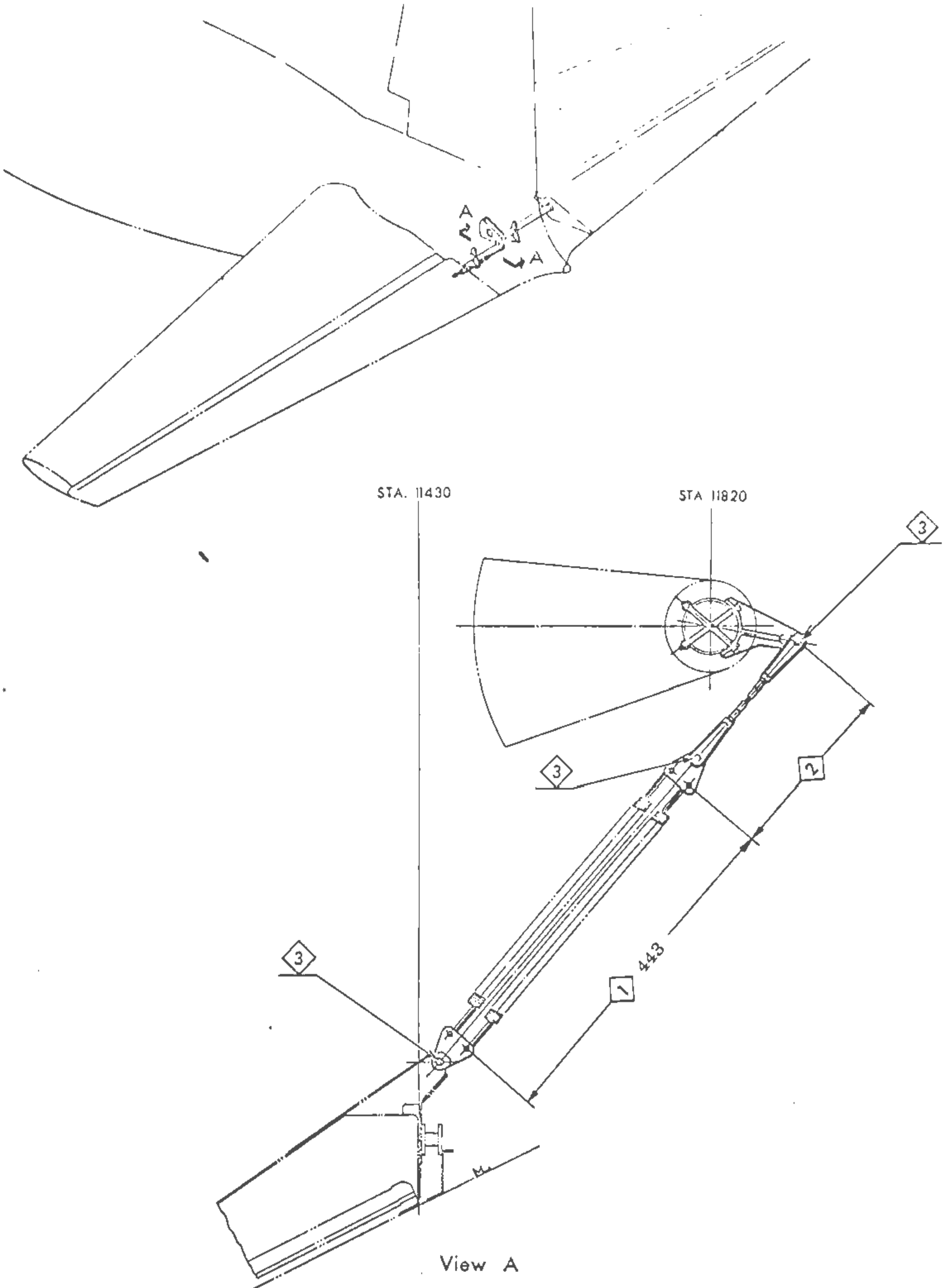
Elevator Balance Tab Hinge

Figure 7-25



Note
B Elevator Hinge Point
C Balance Tab Hinge Point

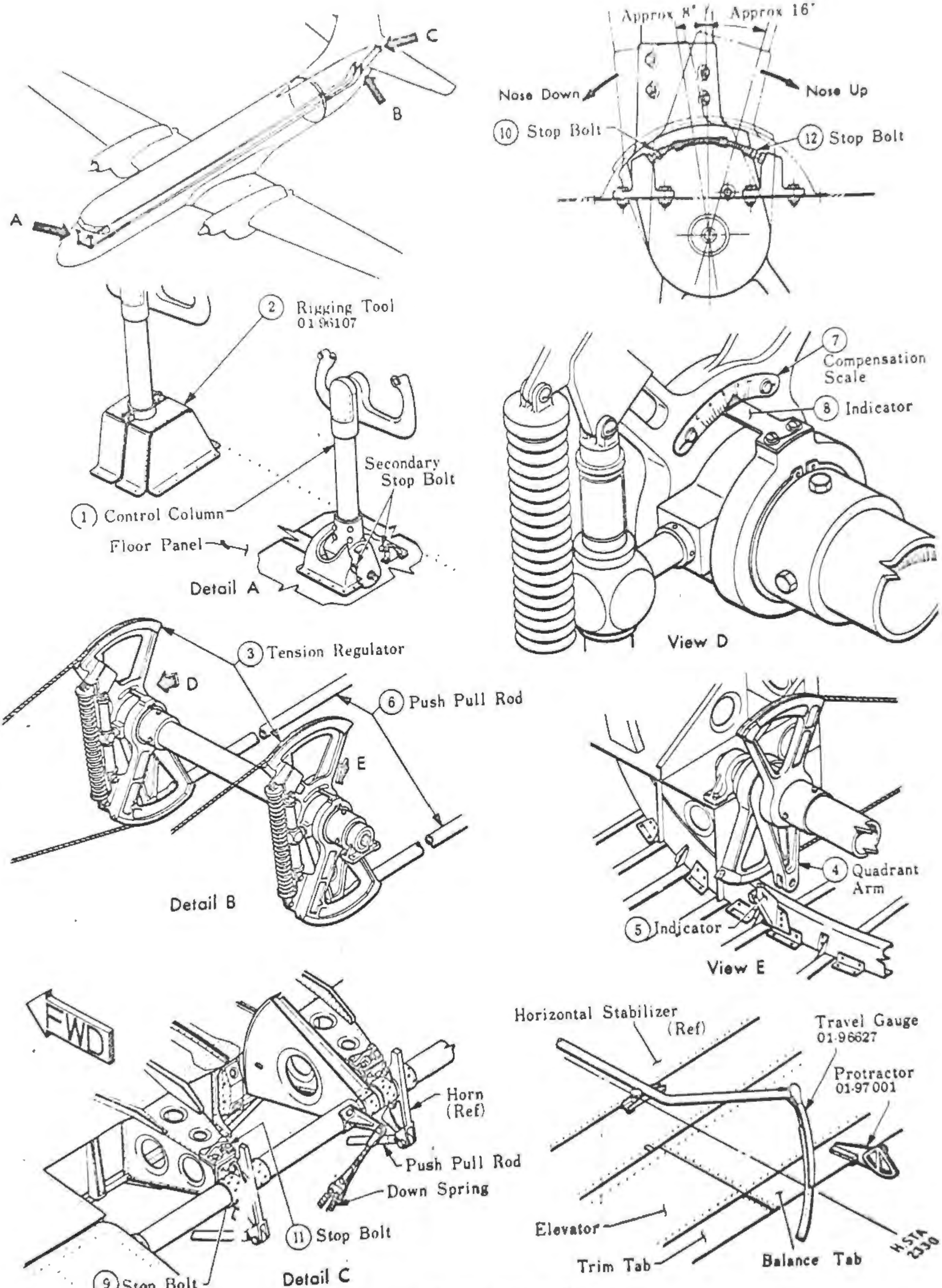
Elevator Balance Tab System
Figure 7–26



View A

Elevator, Down Spring

Figure 7–27



Elevator Control System Rigging

Figure 7–28.

7.7 Elevator Trim Tab Control System

7.7.1 Attachment of Trim Tab (See Fig. 7-29)

The trim tab is attached to the hinge brackets of the elevator with four hinges. On the horn fitting on the front spar of the trim tab is located a push-pull rod connected to the trim actuator.

7.7.2 Trim Tab Control System (See Fig. 7-30)

The elevator trim tab can be controlled by rotating the elevator trim tab control wheel on the center pedestal in the cockpit.

The rotation of the control wheel is transmitted to the cable drum by chains. A cable from the cable drum passes the weight reducing holes of the floor beams, reaches the aft fuselage, bends up at a pulley at Fus. Sta 9480 and transmits the rotation of the control wheel to the screw jack type actuator installed at H.Sta 3000. The actuator actuates the trim tab through the push-pull rod.

7.7.3 Indicator Box (See Fig. 7-31)

On the center pedestal is provided the indicator box which indicates the amount of the elevator trim control.
The rotation of the trim control wheel which can be rotated forward by 0.93 turns and rearward by 0.94 turns, is reduced by the reduction gears and the indication is shown on the dial with graduations marked on the face.

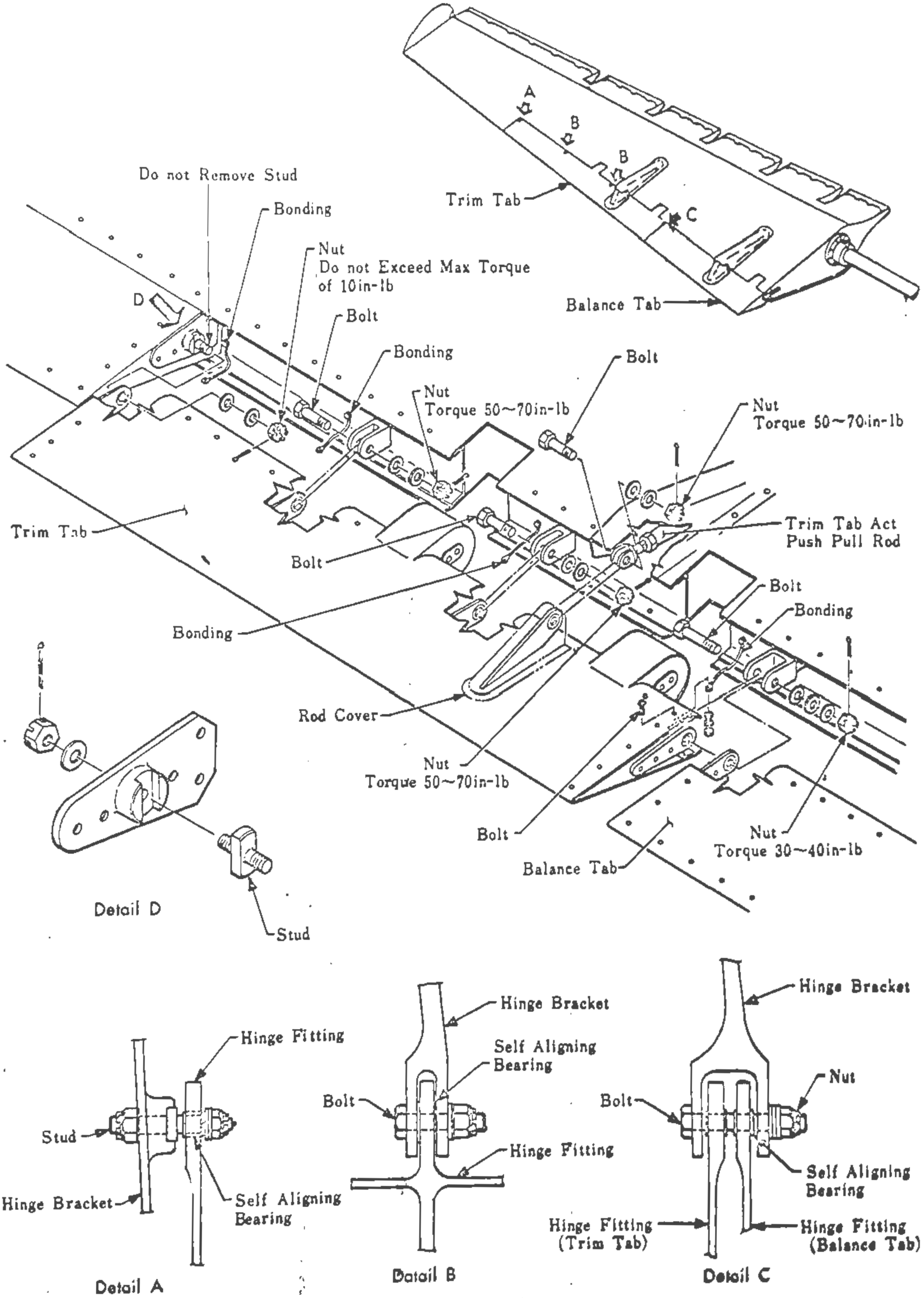
Graduations of Indicator

Rotation of Knob	Indication	Tab Position	Maximum Scale
Forward	Red	Up	10
Rearward	Black	Down	15
0 position	Green	0	-

7.7.4 Procedures for Trim Tab System Adjustment (See Fig. 7-30)

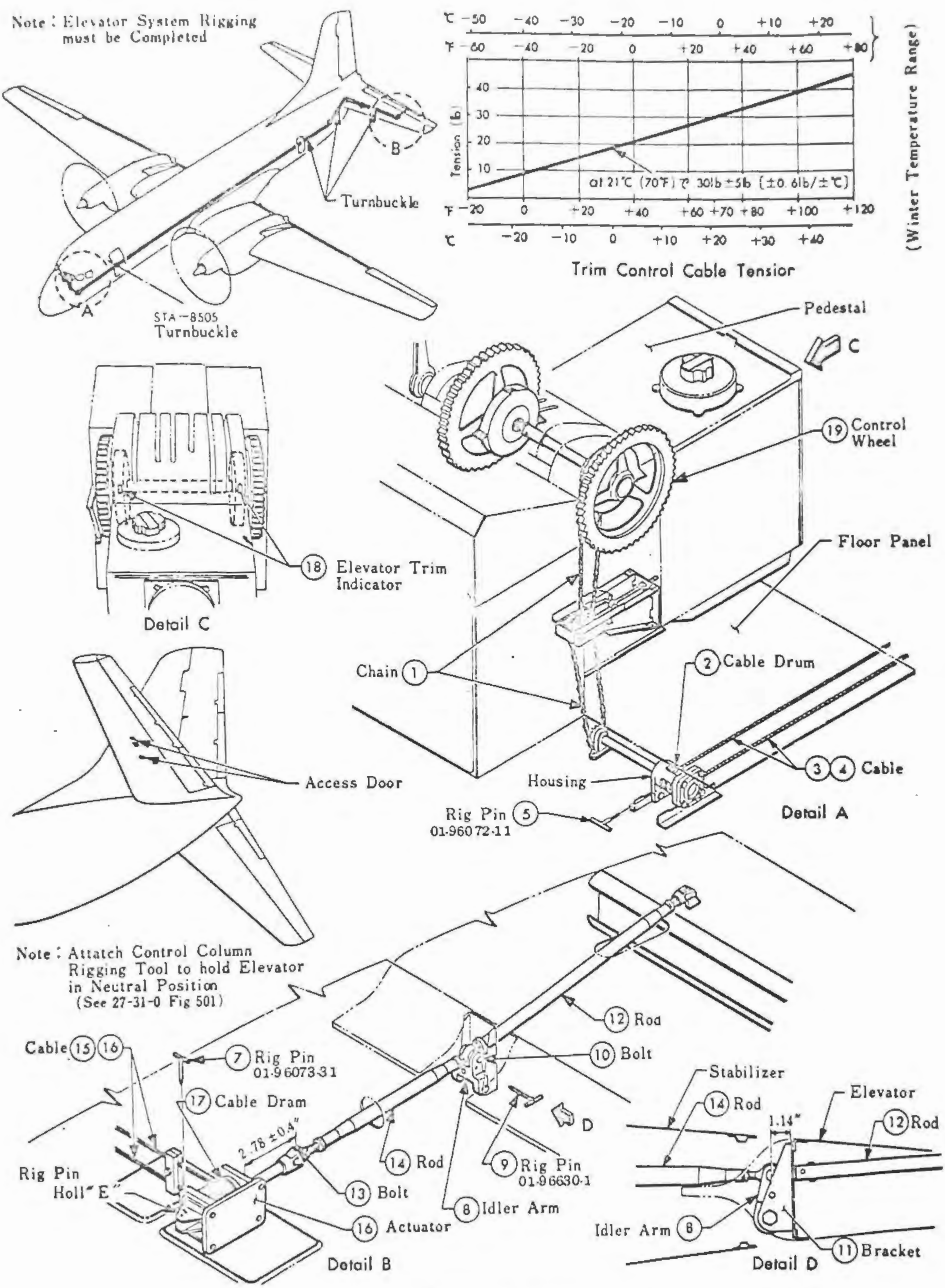
(1) Neutral fixed points of system (3 locations)

Number	Fixed to	Location	Fixing method
1	Cable drum	Cable drum	Rigging pin
2	Trim actuator	Trim actuator	Rigging pin
3	Push-pull rod	Idle arm	Rigging pin



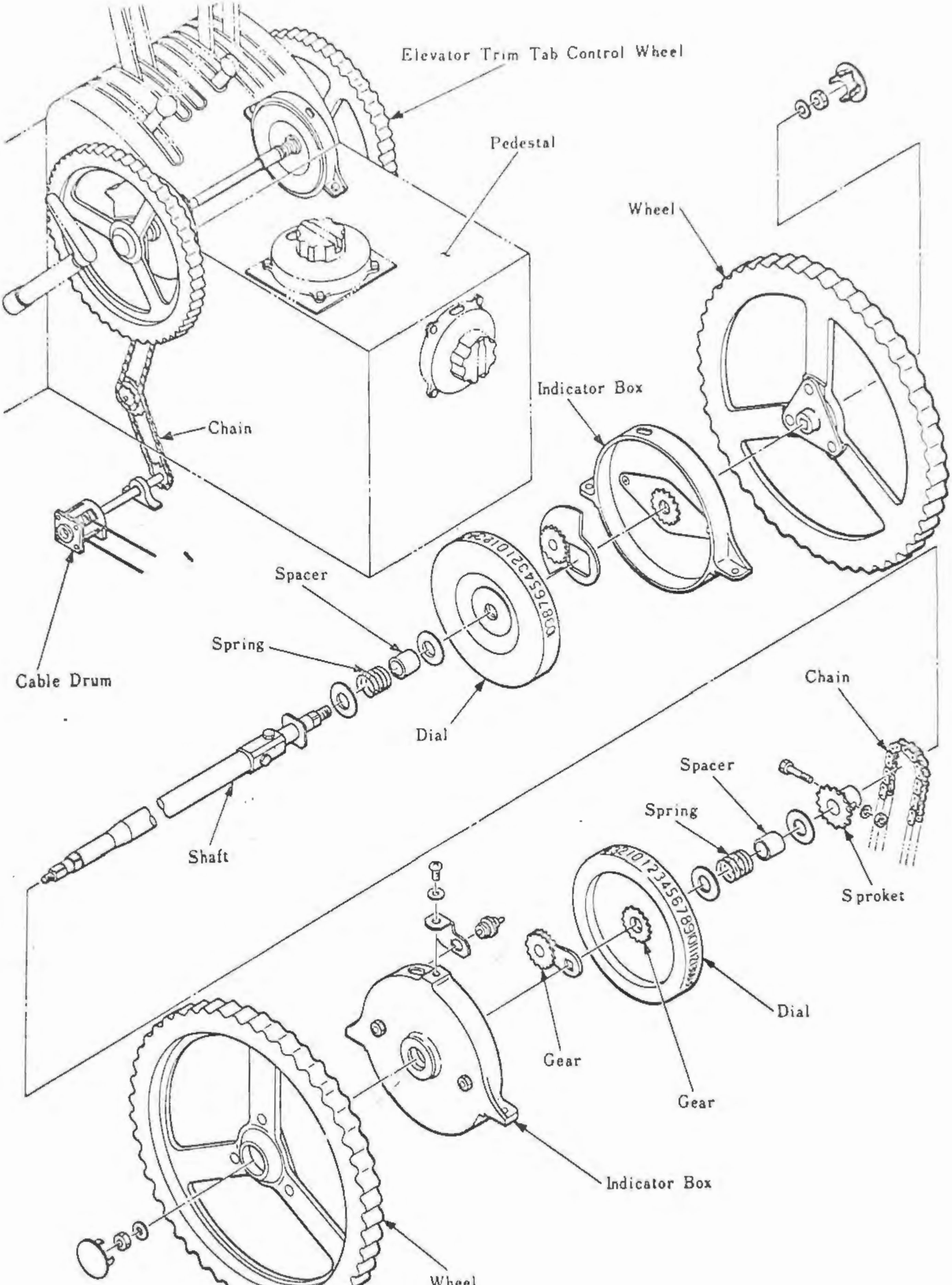
Elevator Trim Tab Hinge

Figure 7-29



Elevator Trim Tab Control System Rigging

Figure 7–30



Elevator Trim Indicator
Figure 7-31

(2) Adjusting Procedures

A. Fix numbers 1, 2 and 3.

B. Fix the elevator and the trim tab at neutral positions.

C. Adjust the push-pull rod.

D. Tighten the cable. The cable tension should be 30 ± 5 lb (±0.4 lb/°F) at 70°F.

Adjustment of Stopper

E. The stopper for the trim tab system is built in the indicator box. The stopper comes in contact if the control wheel is rotated to the full and it can not be moved any further.

7.8 Flap Control System

7.8.1 Attachment of Flap (See Figs. 7-32 and 7-34)

The flaps are of Fowler type and the inboard flap is attached to W.Sta 0 to 4800 and the outboard flap to W.Sta 4800 to 9517 for each wing.

On each flap are attached 2 sets of drag links and 3 sets of carriages. These drag links fixed to the flaps with hinges, are attached to the nut of the actuator screw jack with 4 bolts. Each carriage has 5 sets of rollers (8 ea.) holding ⊥ shape of the track(rail attached on the wing structure from the top, bottom, left and right sides.

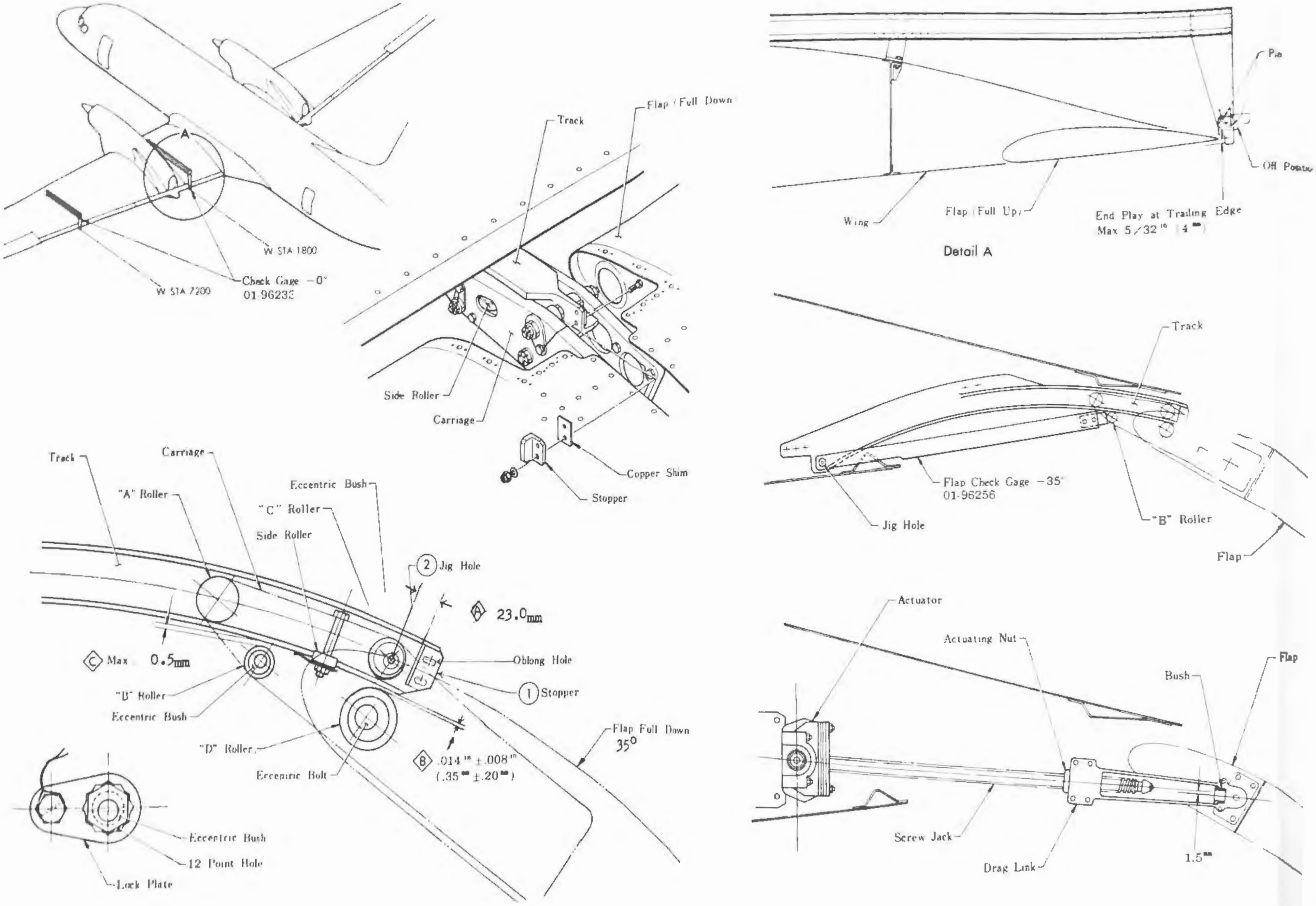
The flap is actuated hydraulically and controlled electrically, being driven by screw jacks.

7.8.2 Flap Control Electrical System (See Fig. 7-33)

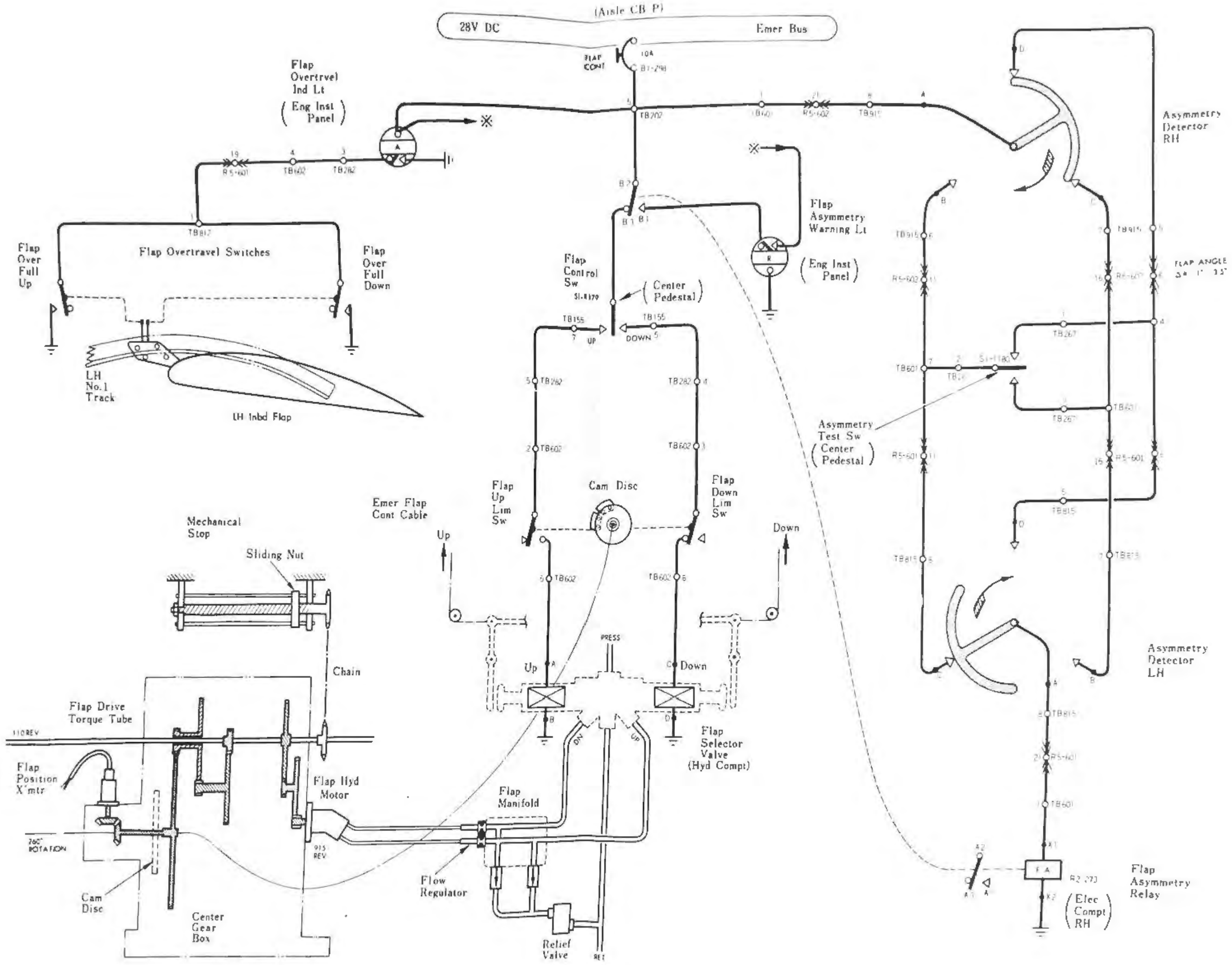
In the hydraulic compartment is provided a flap hydraulic motor which drives the screw jacks. This system consists of simple wiring and three switches since the flap selector valve controlling the flap hydraulic motor is regulated electrically.

(1) Composition

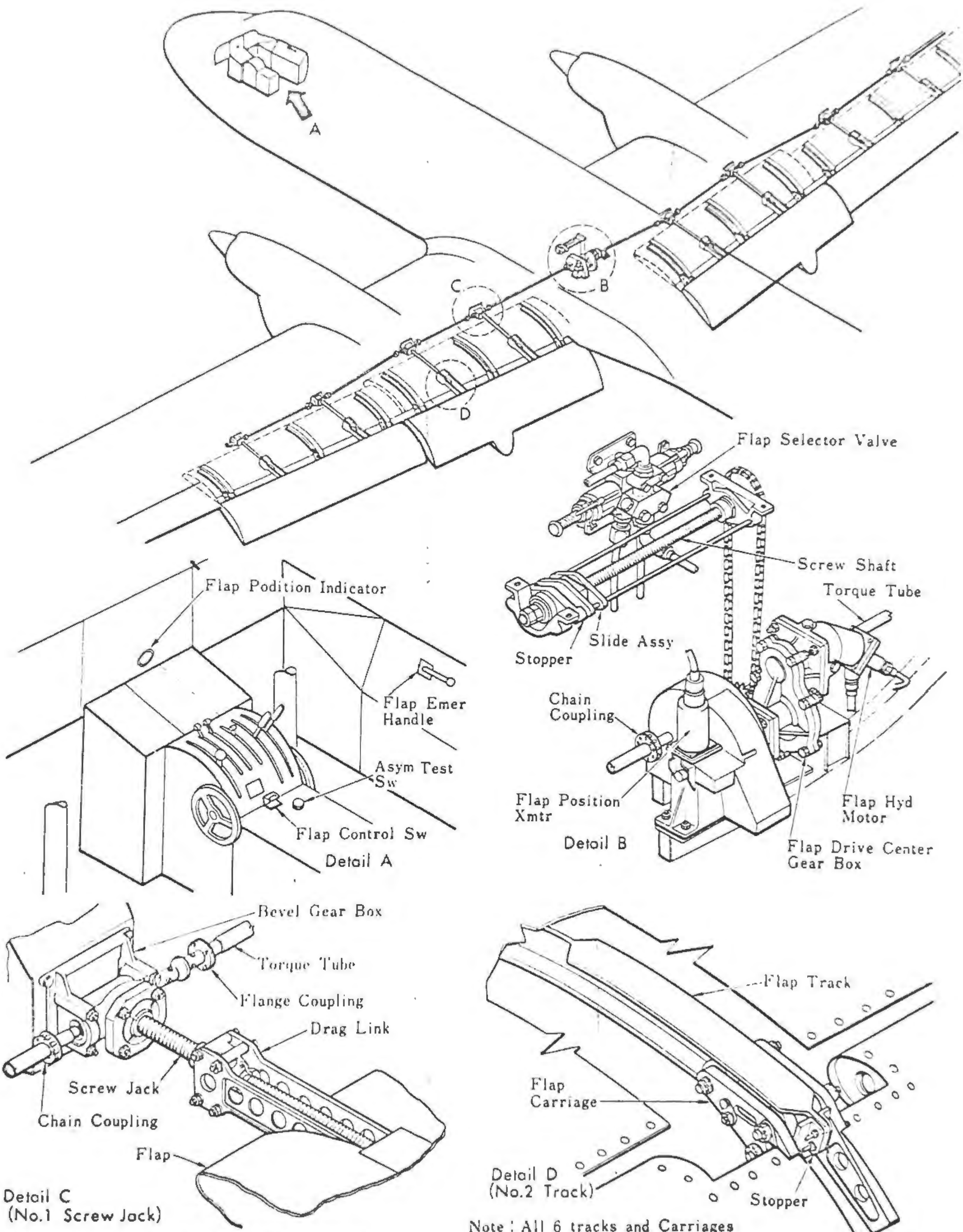
a. Power 28V DC (from the emergency bus)
b. Flap control switch (on the pedestal in the cockpit)
c. Flap limit switch (in the flap center gear box)
d. Flap asymmetry (in the flap well)
e. Flap overtravel (on the track)



Wing Flap Removal/Installation
Figure 7-32



Flap Electric System Schematic
Figure 7-33



Note : All 4 screw jacks are almost identical

Note : All 6 tracks and Carriages are almost identical

Wing Flap System

Figure 7-34

(2) Operation

If the flap control switch is placed in "UP" or "Down," the "UP" side or "Down" side solenoid of the flap selector valve is energized and hydraulic pressure is supplied to the "UP" or "Down" piping, driving the hydraulic motor to rotate the flap drive torque tube through gears and, in turn, move the flap.
If the cam disc rotates as the flap moves, the flap angle reaches 0° or 35°. Then, the flap limit switch is energized, shutting off power supply to the flap selector valve. As the torque tube is connected to the mechanical stop with chains, the flap stops at the mechanical stop if the limit switch is inoperative due to failure or some other reasons. The flap overtravel indicating light beside the flap position indicator on the engine instrument panel comes on.

7.8.3 Flap Hydraulic System (See Fig. 7-35)

This system is provided to drive the flap. Several units have been introduced to maintain the flap driving speeds within reasonable range.

(1) Principal components of Hydraulic System

A. Flap selector valve

B. Flap manifold

C. Flap relief valve

D. Flap hydraulic flow regulator

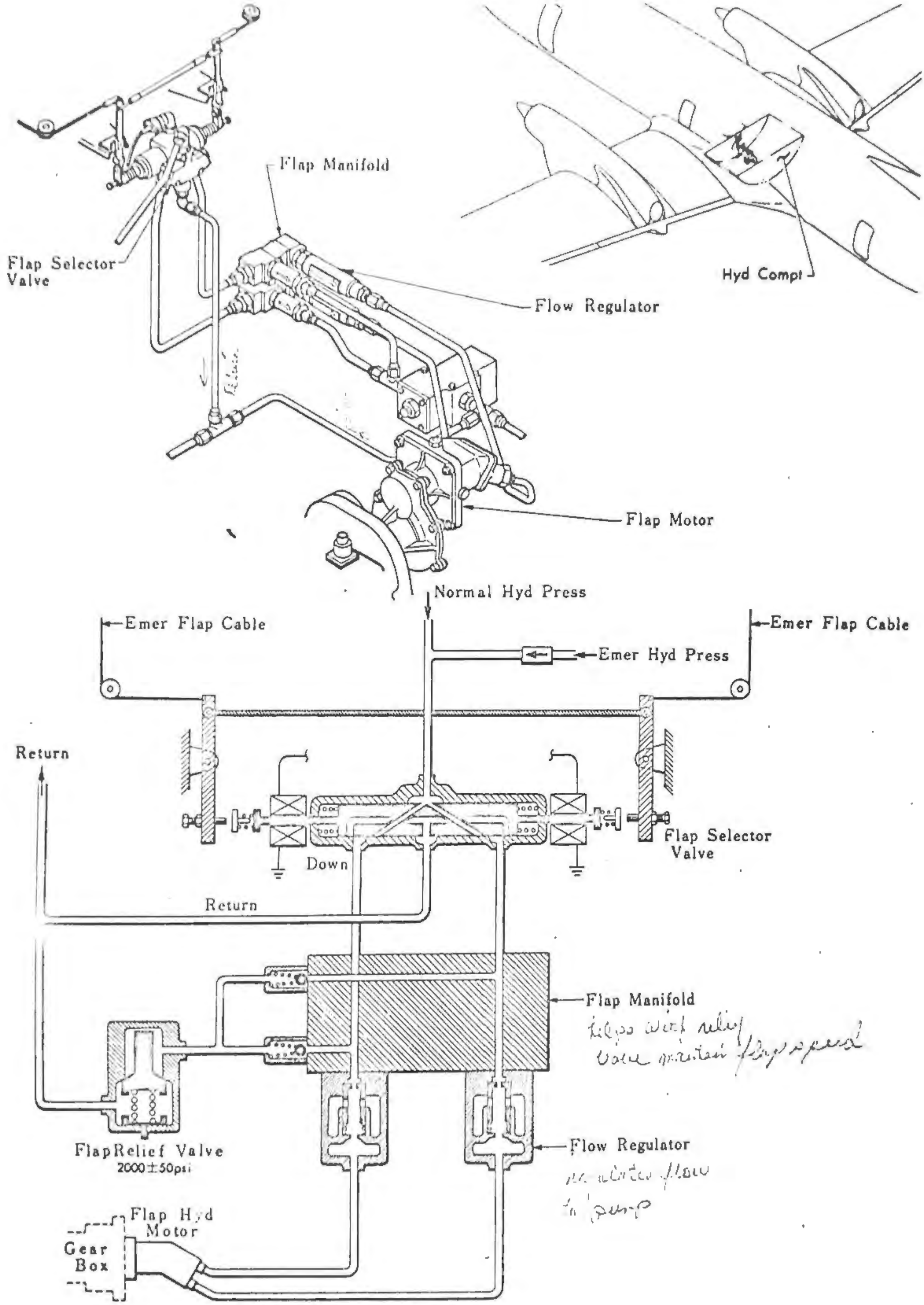
E. Flap drive hydraulic motor

All the above units are located in the left forward portion of the hydraulic compartment.

(2) Operation of the whole system

Hydraulic pressure from the upstream hydraulic power system passes the selector valve line corresponding to the flap control switch, the manifold and the flow regulator successively, driving the hydraulic motor.

At the same time, the hydraulic fluid is connected to the flap relief valve which regulates the system pressure at 2000 psi. If the switch is turned off, the hydraulic motor is locked.

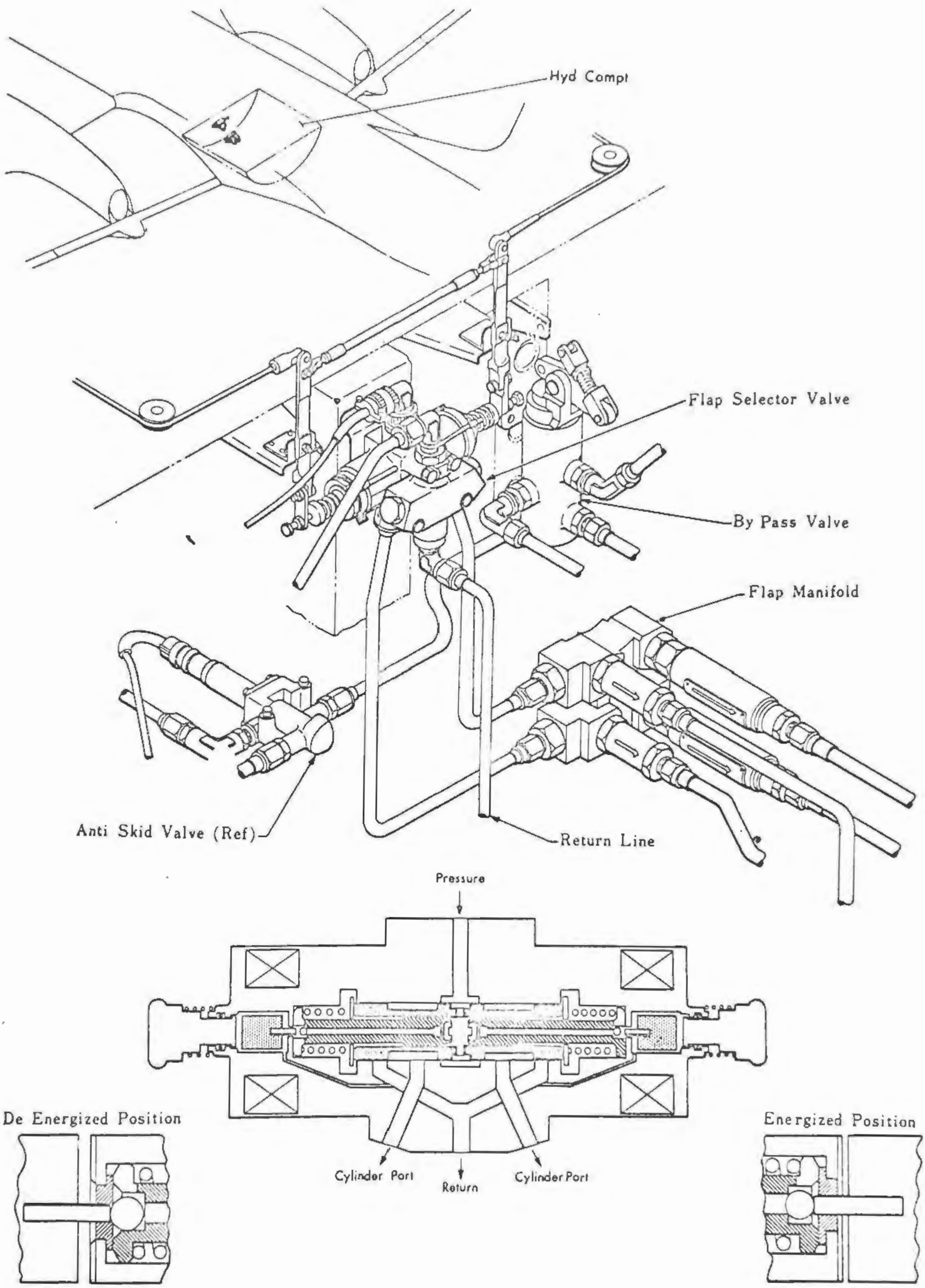


bypass with relief valve maintain flap speed

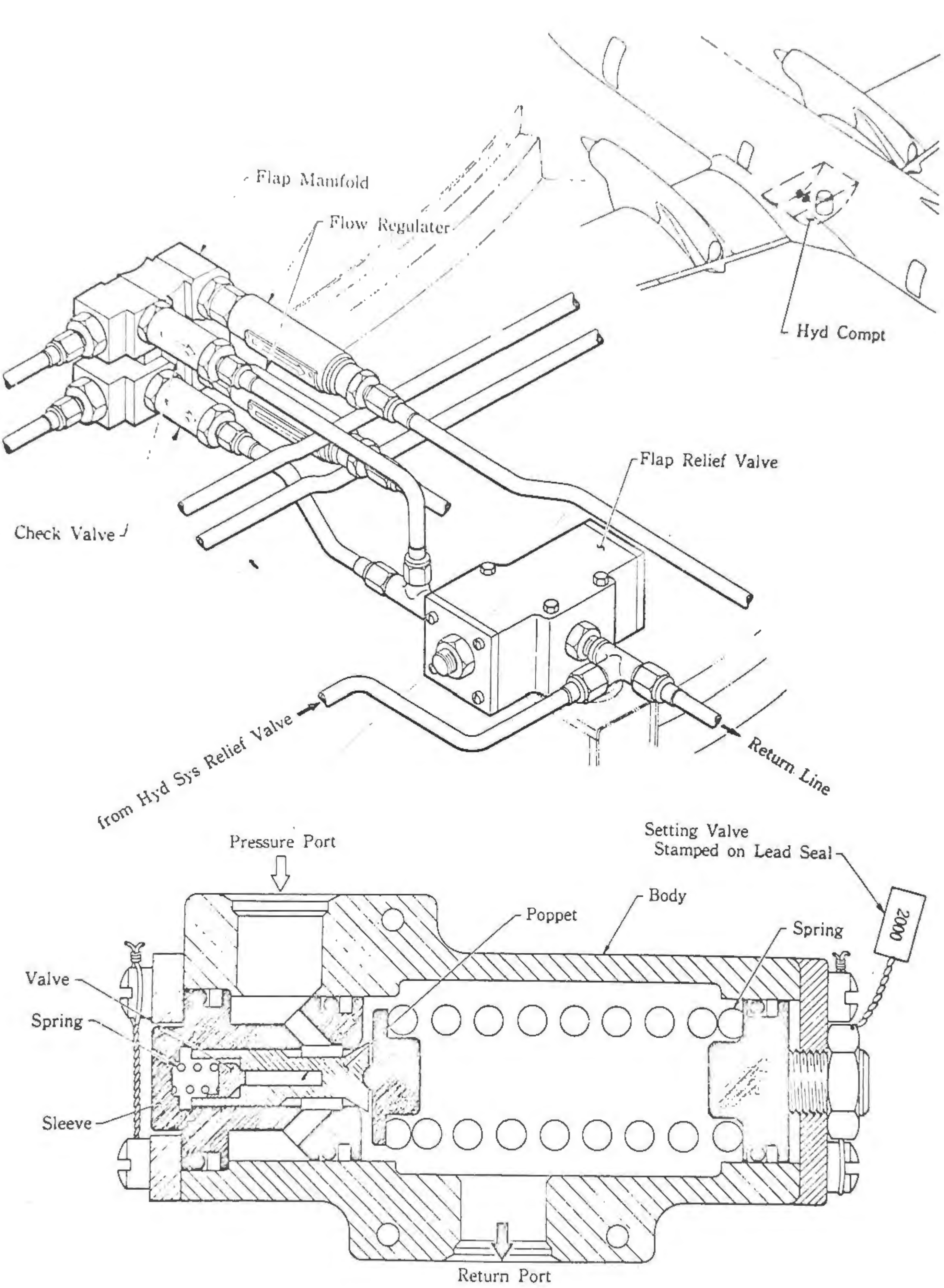
maintain flow to pump

Wing Flap Hydraulic System

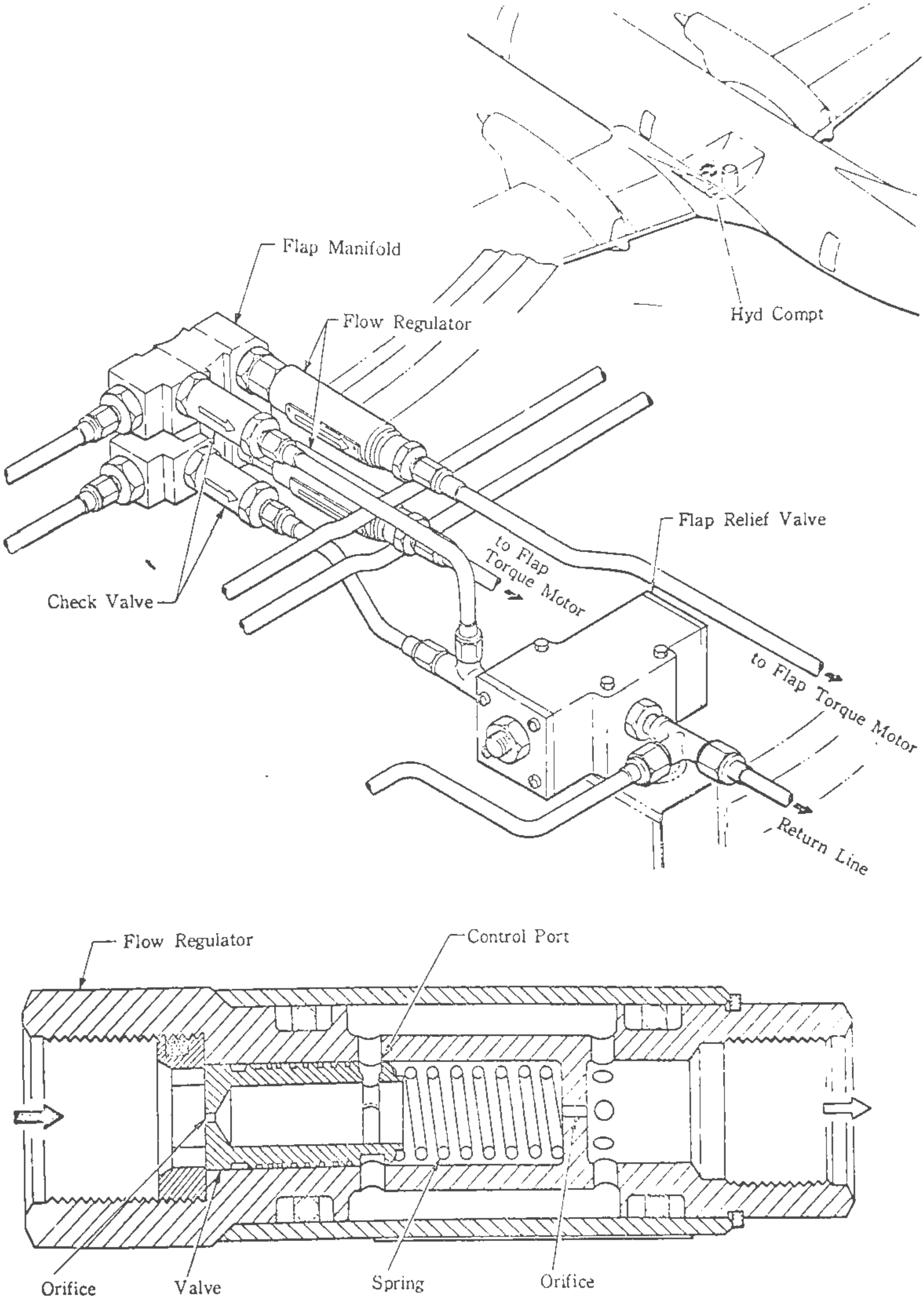
Figure 7-35



Flap Selector Valve
Figure 7–36



Flap Relief Valve
Figure 7–37



Flap Hydralic Flow. Regulator
Figure 7–38

E. Flap Drive Hydraulic Motor

Performance (Vickers Inc.)

Type	Piston type
Max. press. range	3000 psi
Max. speed	4600 rpm
Torque produced	120 in.lb (at 3000 psi)

The hydraulic motor is a piston type motor installed on the flap drive center gear box, producing rotating force by pressure fluid from the flow regulator.

The first gear of the hydraulic motor drives the output shaft, i.e., torque tube at a speed reduced in two steps through a set of gears. The reduction ratio is 8.305.

Another set reduces the output shaft, torque tube in 3 steps, with the first gear attached on the torque tube, at a reduction ratio of 152.51.
The cam disc with reduced speed operates the down and up limit switches. The bevel gear with reduction ratio of 1:1 at the end of the cam drive shaft rotates the flap position transmitter. The output shafts, i.e., torque tubes of the gear boxes for both wings produce a torque of 7.425 Kg.m.

7.8.4 Flap Drive System (See Fig. 7-39)

The flap drive system is operated mechanically.

(1) Construction

A. On each flap are fixed three carriages which slide along the track (rail) installed on the wing structure.

B. On each flap are attached two drag links with hinges.
Each drag link is attached to the nut of the actuator screw jack with four bolts.

C. The actuators for the flaps are connected together with a torque tube. The torque tubes of the L.H. and R.H. flaps are connected together at both ends of the output shaft of the center gear box.

Numbering of Components of Drive Mechanism

Drive Mechanism	Number (Both Wings)	L.H. Wing	R.H. Wing
Torque tube	10	In fuselage No. 1 in numerical order . . . Most outboard No. 5	Same as the L.H. wing
Flap actuator (Screw jack)	8	Inboard No. 1 No. 2 Outboard No. 3 No. 4	Same as the L.H. wing
Drag link	8	Inboard No. 1 No. 2 Outboard No. 3 No. 4	Same as the L.H. wing
Track	10	Inboard No. 1 No. 2 No. 3 Outboard No. 4 No. 5 No. 6	Same as the L.H. wing
Carriage	10	Inboard No. 1 No. 2 No. 3 Outboard No. 4 No. 5 No. 6	Same as the L.H. wing

(2) Principal Components of Drive System

A. Hydraulic motor and flap drive center gear box.

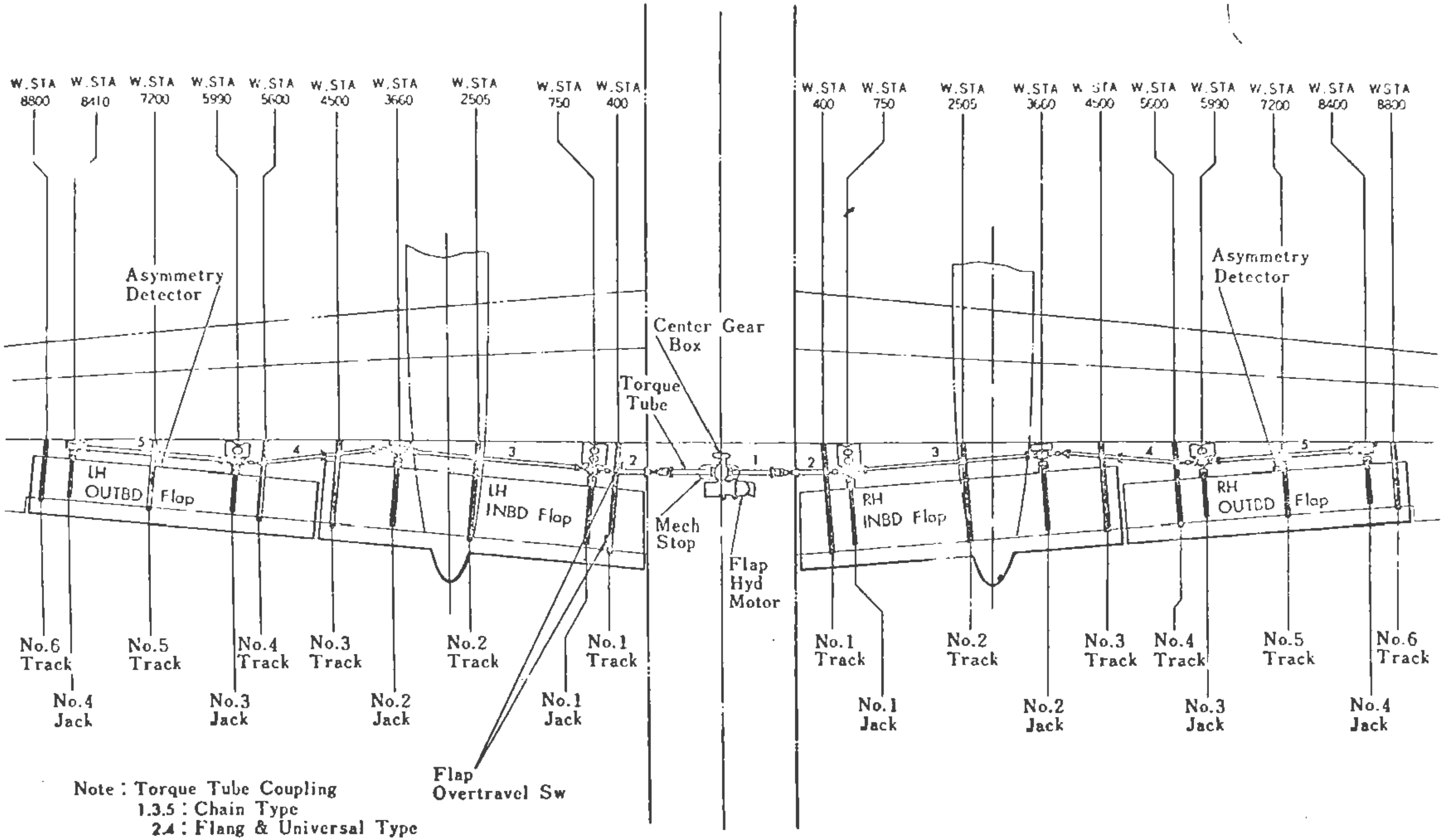
B. Flap mechanical stop

C. Torque tube

D. Flap actuator
Screw jack
Drag link

E. Carriage

F. Track (rail)



Note : Torque Tube Coupling
1.3.5 : Chain Type
2.4 : Flang & Universal Type

Wing Flap Drive System
Figure 7-39

4 Gear Boxes

6 TRAC's

2 screwjacks per flap

5 [illegible]

Chain

universals

[illegible]

(3) Operation of the Whole System

The torque of the flap hydraulic motor drives the torque tube through the gear box, driving the screw jack by the actuator to operate the flap.

A. Flap angle

$35^\circ {}^{+0^\circ}_{-1^\circ}$

B. Actuating time

Full stroke of the normal travel angle up 25 to 30 sec.
down 22 to 26 sec.

C. The amount of rotation of each component while the flap moves from 0° to 35°

Center gear box	input shaft (hyd. motor shaft)	805 revolutions
	Cam plate	227.5°
Torque tube		97 rev.
Actuator screw jack		35.5 rev.

D. Asymmetry protection

The asymmetry detectors located on the L.H. and R.H. outboard flaps stop the flaps when the difference of the L.H. and R.H. flap angles reaches 1° to 3.5°, lighting the warning lamp at the same time.

E. Flap Overtravel Switch

These switches are provided on the L.H. wing only, i.e., on the up side and the down side 1 ea., lighting the flap overtravel indicating lights on the R.H. part of the flap position indicator on the engine instrument panel when the flap overtravels the specified travel angle, stopping at the mechanical stop in case of failure of the up or down limit switch or flap overtravelling by emergency flap handle.

(4) Operation of Principal Components (See Figs. 7-40 and 7-41)

A. Hydraulic Motor and Flap drive Center Gear Box

The hydraulic motor of piston type produces 7.425 Kg.m of total torque at the output shaft through two sets of gears.
The gear train consists of

(a) Torque tube drive gear pinion and
(b) Cam and transmitter drive gear train.

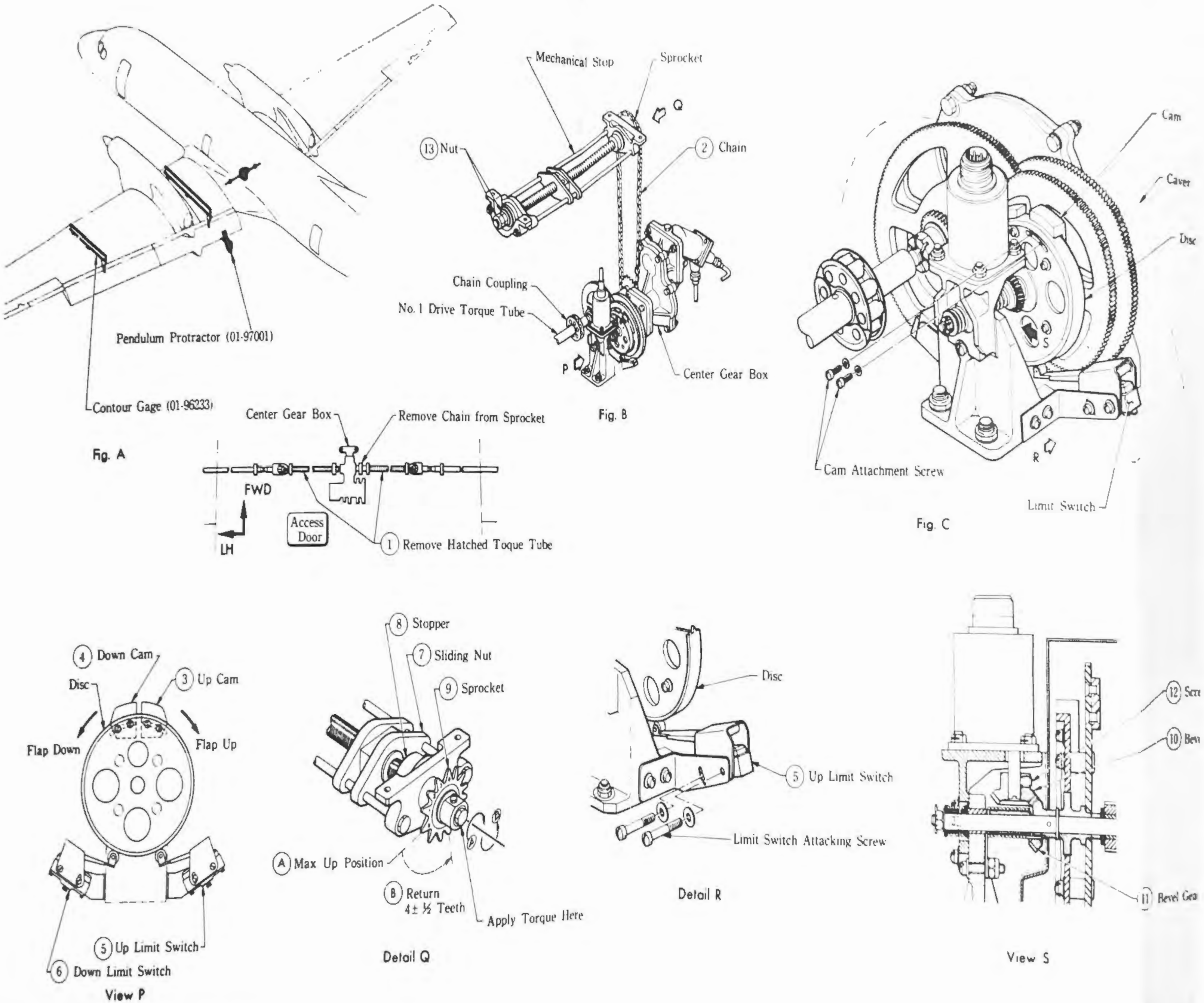


Fig. A

Fig. B

Fig. C

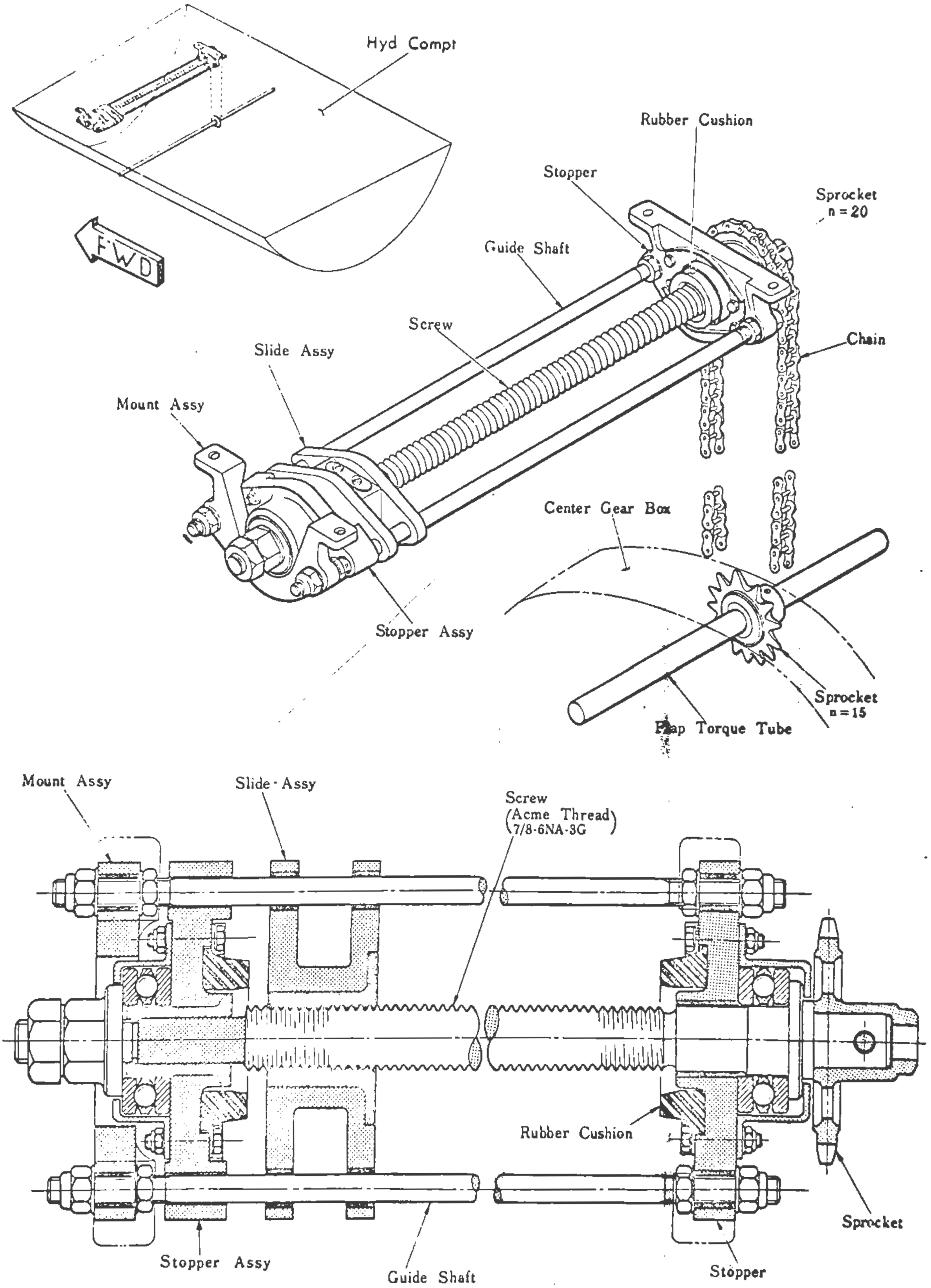
View P

Detail Q

Detail R

View S

Wing Flap Center Gear Box Adjustment
Figure 7-40



Flap Mechanical Stop
Figure 7–41

D. Flap Actuator (See Figs. 7-42 and 7-43)

The flap actuators are provided 2 ea. on the flaps. The L.H. and R.H. inboard flaps are interchangeable between them. So are the outboard flaps.
It consists of the bevel gear box and the screw jack. The rotation of the torque tube is reduced to 14/38 by the screw jack gear box, being transmitted to the screw jack. The outboard flap has 3 Acme nuts. The actuators are connected to the drag links installed 2 ea. on the flaps with 4 bolts at the actuating nut section, driving the flaps.

E. Carriage (See Fig. 7-44)

On each flap are fixed 3 carriages. The carriage with 5 sets (8 ea.) of rollers holds the ⊥ shape portion of the track from the top, bottom, left and right. The rollers are assigned symbols for identification. They are called A, B, C and D rollers from the front side of the carriage but no symbols are assigned to the two side rollers. However, they are called E tentatively in this training guide.

Name of Roller	Kind
A Roller	Ordinary roller
B "	Adjustable roller
C "	"
D "	"
E (side roller)	Rollers on No. 1, No. 3, No. 4 and No. 6 tracks are adjustable. Rollers on No. 2 and No. 5 rollers are ordinary ones.

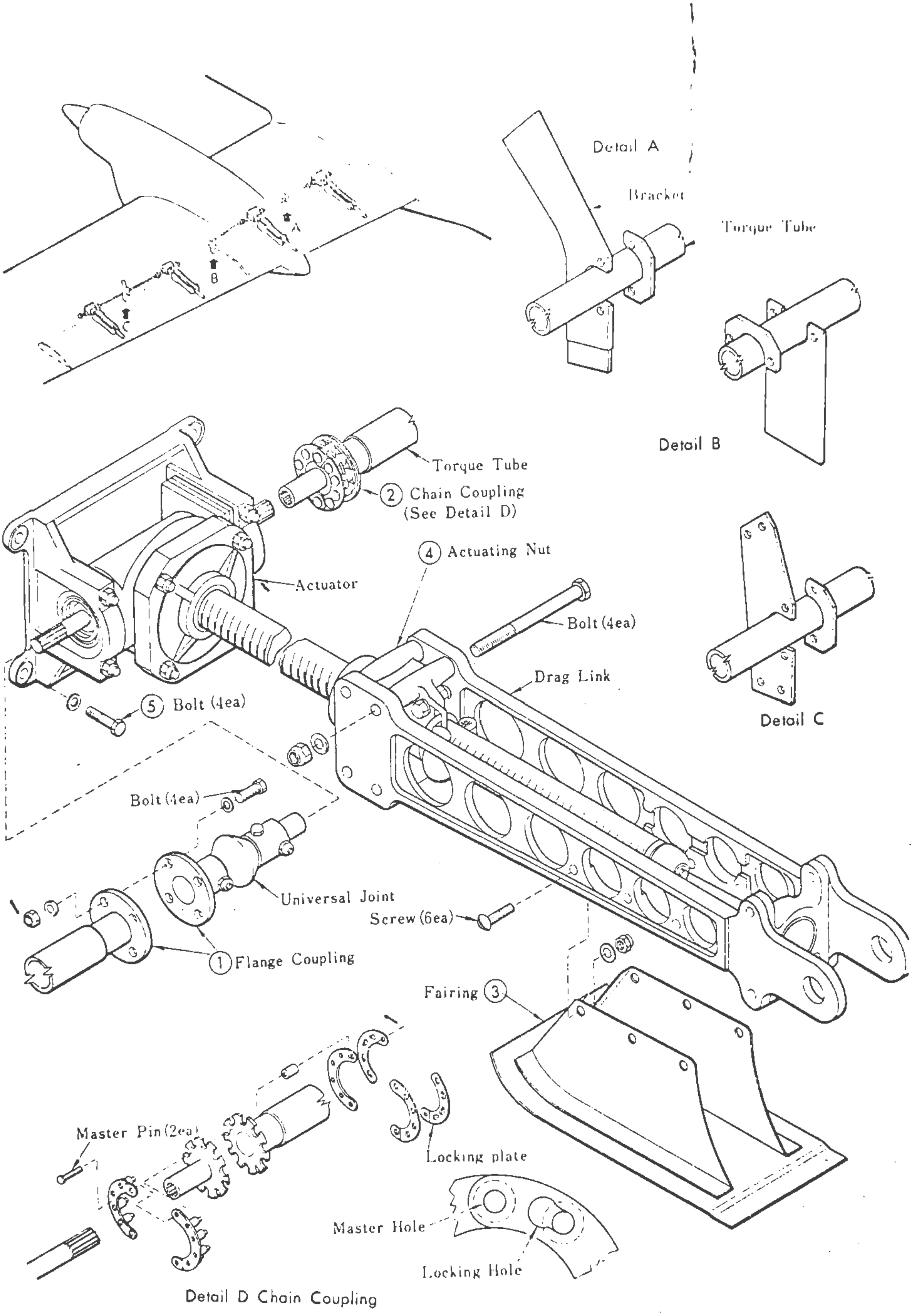
The attachment of the flap is adjusted by means of these carriage rollers.

F. Track (rail) (See Fig. 7-44)

The track constitutes a part of the wing leading edge structure. There are three tracks (rails) attached on the wing structure for sliding the flap. The track has two sections; I section and ⊥ section, made of Cr-Mo steel (4140) with hard chrome plating.
As the track is a perfect arc, the flap rotates from 0° to 35° around an imaginary center shaft. The three tracks on each falp has the same curvature.

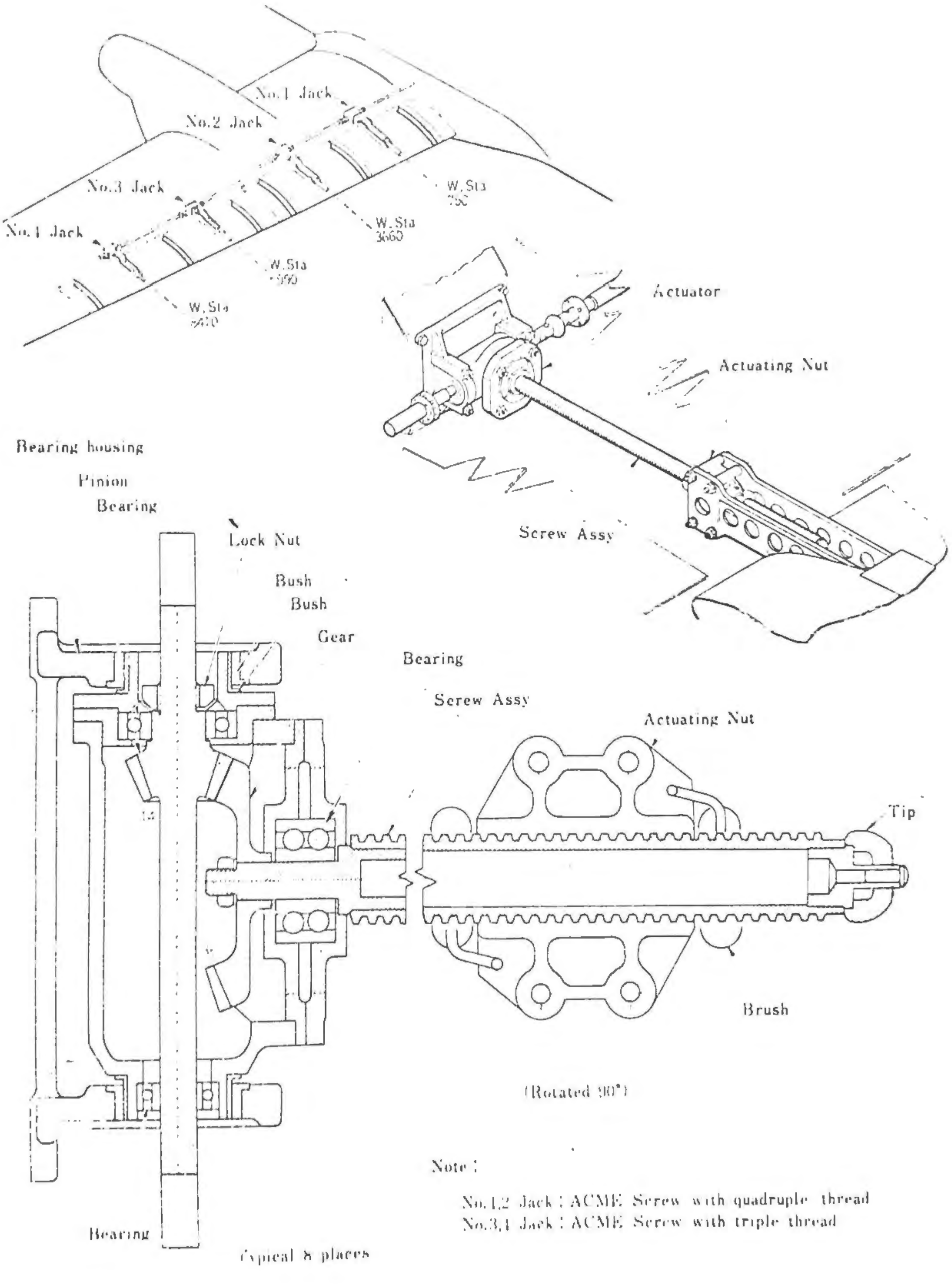
7.8.5 Flap Operation

The falp operation consists of the normal operation and the emergency operation systems. The normal operation is described below, while the emergency operation is dealt with in Chapter 6.



Flap Actuator Remove Installation

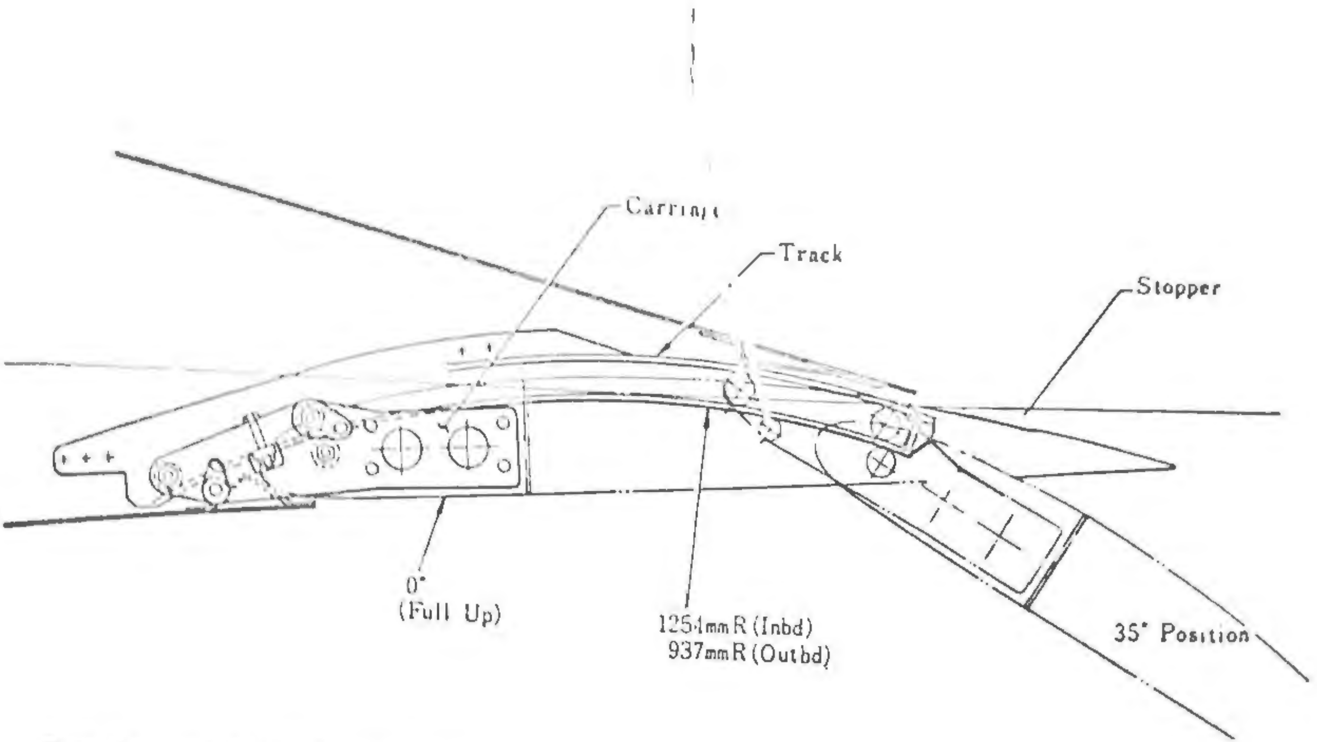
Figure 7-42



Note :

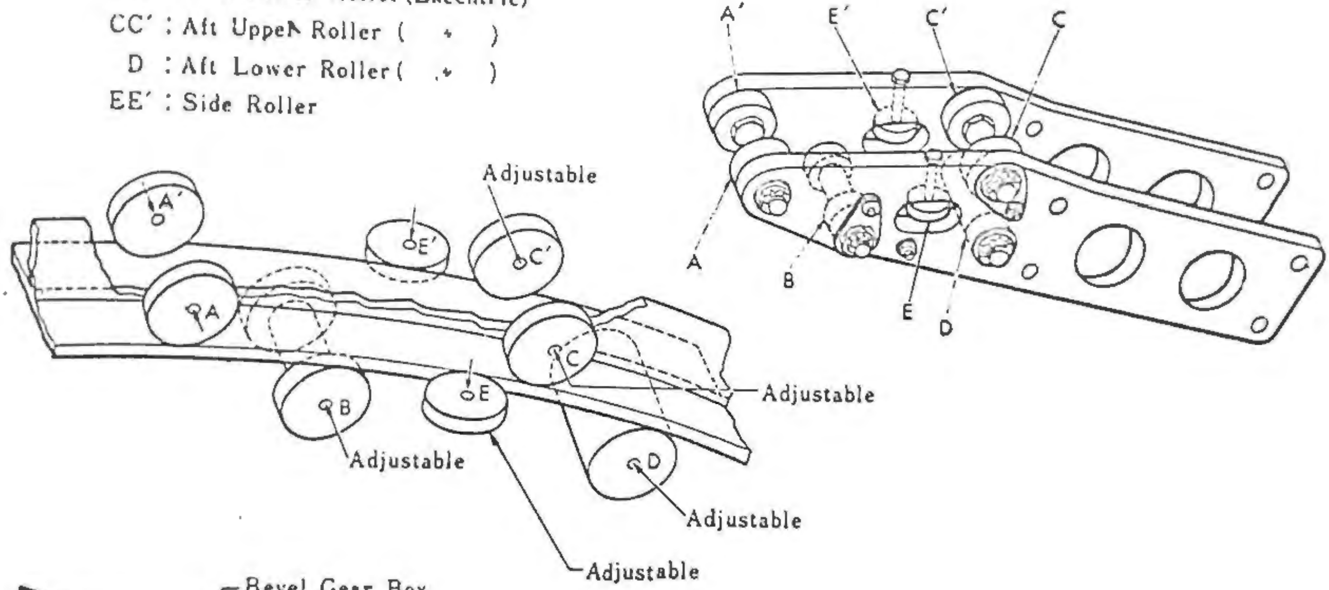
No.1,2 Jack : ACME Screw with quadruple thread
No.3,4 Jack : ACME Screw with triple thread

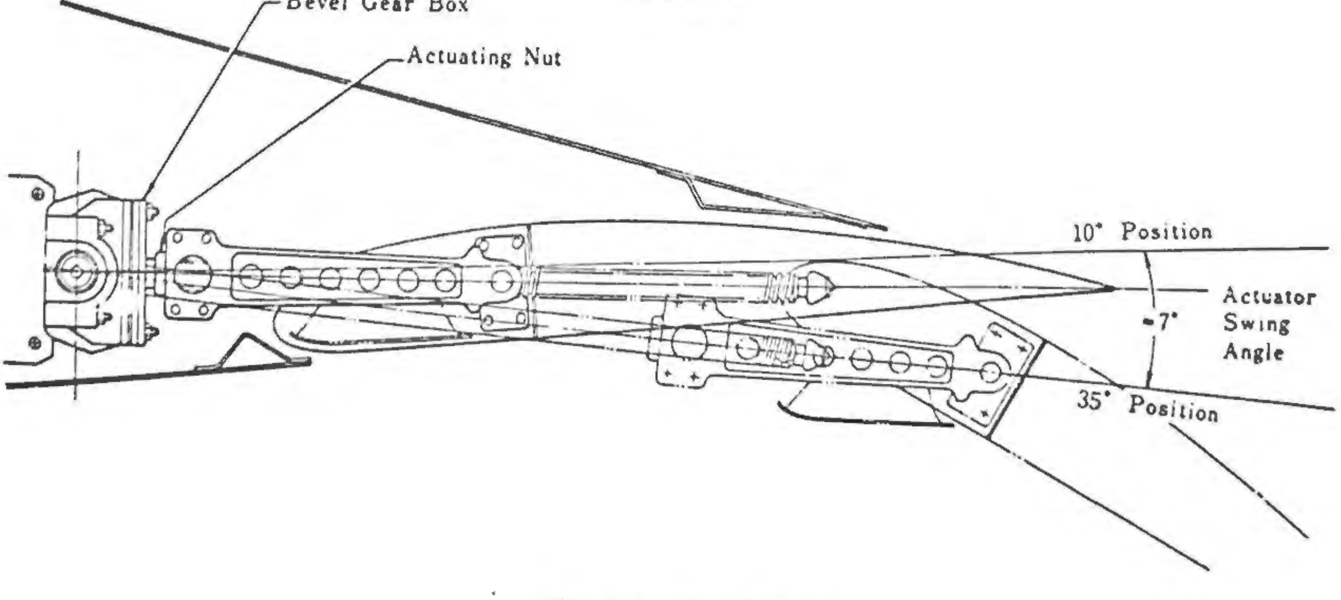
Flap Actuator
Figure 7-73



Flap Carriage Roller Arrangement

AA' : Fwd Upper Rollers
B : Fwd Lower Roller(Excentric)
CC' : Aft Upper Roller ( )
D : Aft Lower Roller ( )
EE' : Side Roller





Wing Flap Drive System
Figure 7–44

If the flap control switch on the center pedestal is placed in "down" or "up", the solenoid selector valve in the hydraulic compartment is energized, supplying pressure oil to the hydraulic motor which begins to rotate. The rotating torque of the motor is transmitted to the torque tube through the gear box, rotating the screw jack to drive the flap.

On the flap is provided a sprocket which drives the slide nut of the mechanical stopper of the flap system.
In the gear box is located a cam disc which rotates together with the gear. If the flap completes its travel over the full stroke, the cam shuts off the limit switch, de-energizing the solenoid of the selector valve. Thus, the supply of pressure oil to the hydraulic motor is shut off, stopping the hydraulic motor and locking it hydraulically.

If the flap overtravels, the limit switch installed on the track of the flap is energized, lighting the indicator light on the instrument panel. Then, the flap control switch must be turned off.
If the flap control switch is turned off (neutral), the flap stops at any position.
The flap angle signals are transmitted to the instrument in the cockpit by the position transmitter installed on the gear box, indicating the flap angle on it.

7.8.6 Emergency Control System (See Figs. 7-45 and 7-46)

This system permits the manual control of the flap selector valve of the system in the hydraulic compartment in case of failure of the electrical system for the flap drive system.

On the R.H. panel for the copilot is provided the flap emergency handle which is connected to the cable through a crank. The cable, adjusted to a tension of 13 kg ± 1 kg, is connected to the lever actuating the selector valve.

If the emergency handle is moved "up" or "down", the selector valve completes a hydraulic passage mechanically, driving the flap. In this case, however, the limit switch does not work electrically, necessitating the manual control.

7.8.7 Procedures for Flap Control System Adjustment

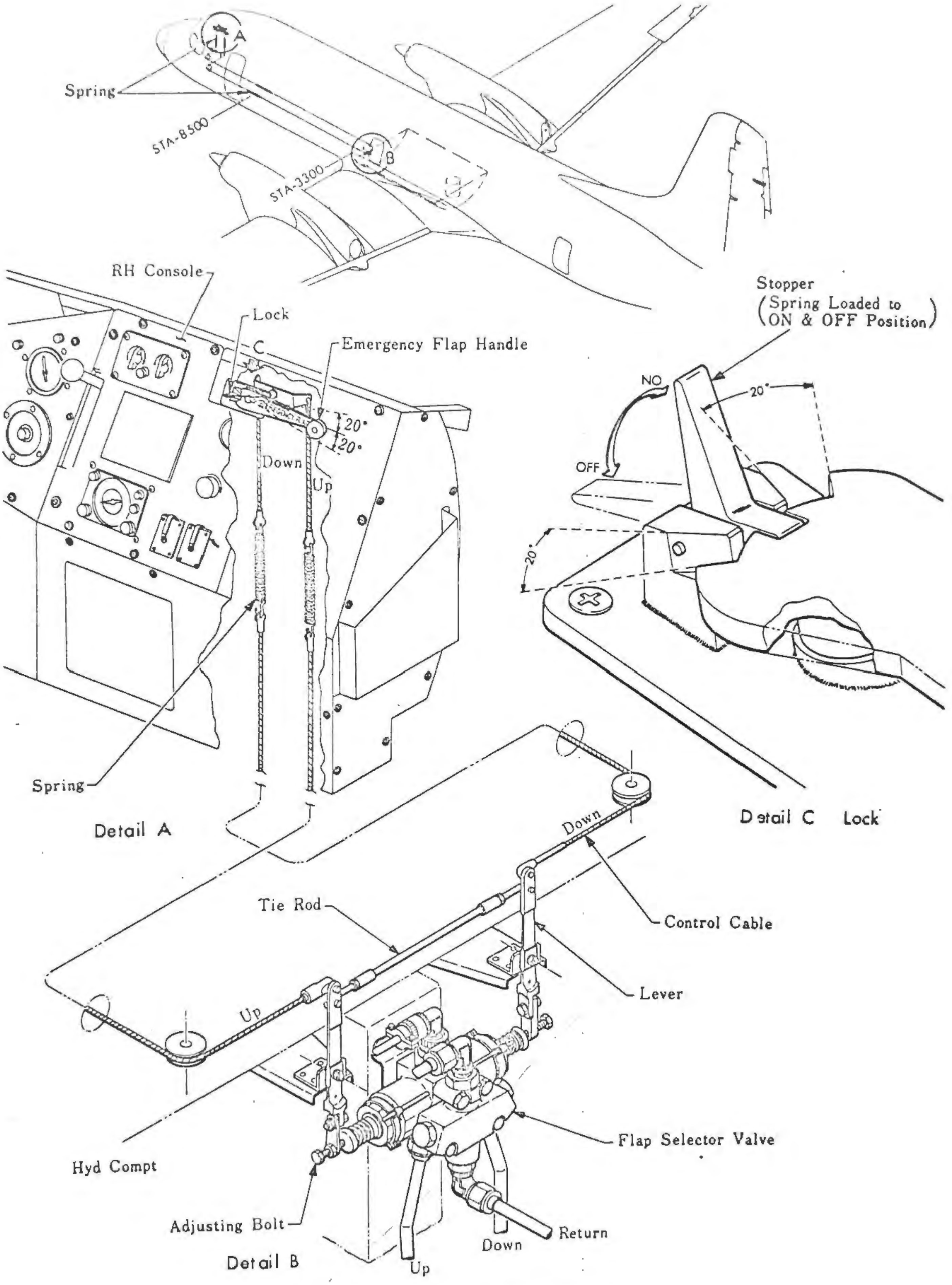
Use the counter gauge to measure flap 0° which is used as datum for various adjustments.

(1) Adjustment of Flap Attachment (Figs 7-32 and 7-44)

A. Attach the outboard and inboard flaps to the flap rails with carriage rollers A, B, C, D and E.

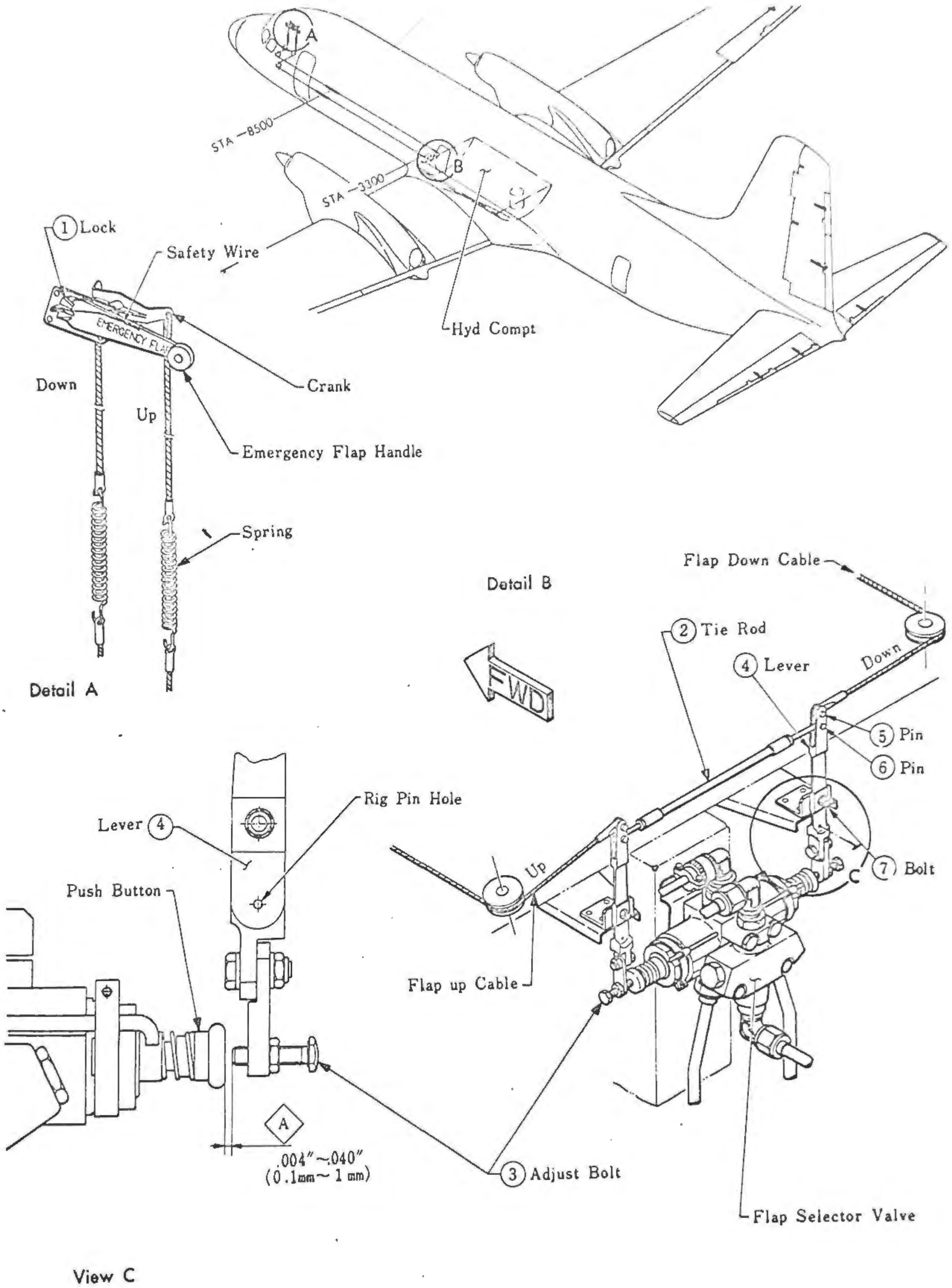
B. Check parallelism of each flap. Adjust it by rotating the torque tube.

C. Tighten the bolt of the actuating nut so that the misalignment of each screw jack and drag link bush is less than 1.5mm.

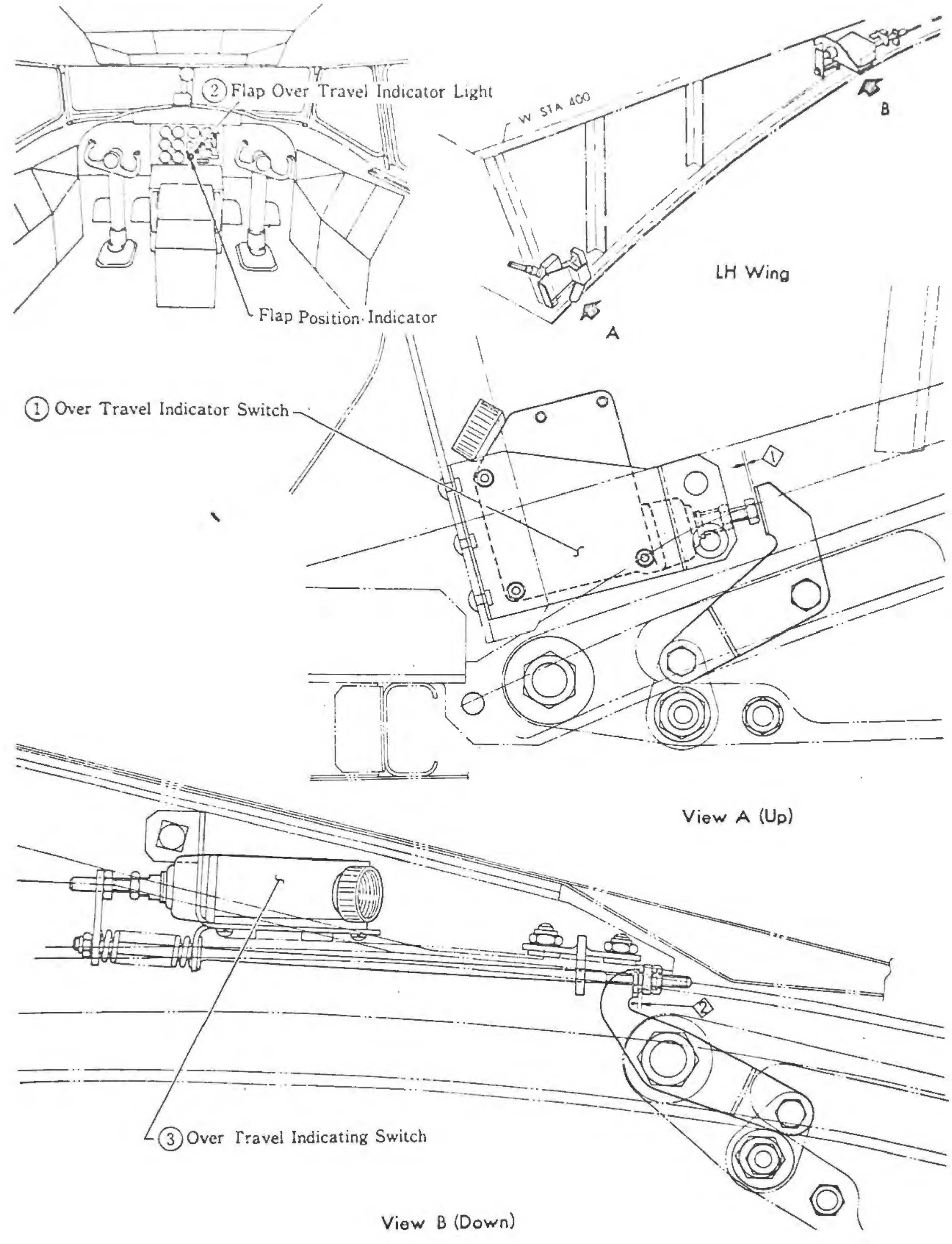


Wing Flap Emergency Control System

Figure 7–45



Wing Flap Emergency Control System Maintenance Practices
Figure 7–46


② Flap Over Travel Indicator Light
Flap Position Indicator
W STA 400
B
LH Wing
A
① Over Travel Indicator Switch
1
View A (Up)
2
③ Over Travel Indicating Switch
View B (Down)

Flap Position Indicator

Figure 7-46A

7.8.8 Flap Asymmetry Protection System (See Figs. 7-47 and 7-48)

This system cuts off the electrical circuit to the flap selector valve, lighting the warning lamp at the same time, if asymmetry of 1° to 3.5° is detected between the flap angles of both wings.

This system is also provided with a test circuit. The asymmetry detectors are installed 1 ea, on the trailing edges of the L.H. and R.H. wings. The asymmetry is detected from the angles of the outboard flaps.

(1) Principal Components

A. Flap asymmetry detector
B. Flap asymmetry system return spring
C. Flap asymmetry relay
D. Flap asymmetry test switch

A. Flap Asymmetry Detector

The detector is installed inside the No. 5 track (center) of the outboard flap in the flap well, 1 ea. on the L.H. and R.H. flaps.

The main body consists of 3 cam plates and the corresponding limit switches located on the same shaft and the movement of the flap rotates the cam shaft through an actuating cable connected to the leading edge of the flap.

B. Flap Asymmetry Return Spring

This draws in the actuating cable when the flap is up.

C. Flap Asymmetry Relay

This consists of two sets of contacts. One set is used to shut off power supply to the flap selector valve, while the other is not in use.

A. Flap Selector Valve (See Fig. 7-36)

Performance (Sumitomo Precision Industry Co.)

Min. operating pressure	250 psi		
Pressure range	Rating	Press. side	Return side
		3000 psi	1000 psi
	Proof pressure	4500 psi	1500 psi
Operating time	Electric circuit	Close	Within 0.04 sec.
	Electric circuit	Open	Within 0.10 sec.

This is an electro-magnetically operated 4 way valve. Its up and down lines are closed when electric power is not supplied to it. The up and down ports are switched by opening or closing the valve inside electro-magnetically. If hydraulic pressure is not available, the ports are not switched even though electric power is supplied. The emergency flap handle pushes the buttons on the valve mechanically through a cable to drive the flap.

B. Flap Manifold (See Fig. 7-35)

The hydraulic fluid coming from the up or down port of the flap selector valve is divided in this manifold to the flow regulator and the flap relief valve through a check valve.

C. Flap Relief Valve (See Fig. 7-37)

(Teijin Seiki Co.)

The hydraulic fluid divided in the manifold, regulates the flap operating speed, and it is also regulated by the relief valve at 2000^{+50}_{-0} to avoid fast cut-in and cut-out cycle of the unloading valve. The hydraulic oil from the relief valve goes to the return line and the remaining portion goes to the flow regulator.

D. Flap Hydraulic Flow Regulator (See Fig. 7-38)

(Teijin Seiki Co.)

In the up line and the down line of the flap manifold outlet are provided the flow regulators of the same type, 1 ea. The hydraulic pressure of this flow regulator is above 70 psi, the flow being regulated at 1.75 GPM in the down side and 1.5 GPM in the up side. The hydraulic fluid thus regulated flows into the hydraulic motor.

(a) Torque tube drive gear train

The first gear driven by the hydraulic motor drives the output shaft to the torque tube at a speed reduced in two steps. The reduction ratio is 8.301.

(b) Cam and transmitter drive gear train

This consists of another set of gears installed on the output shaft of the (a) set.

The output shaft drives the cam disc and the flap position transmitter through the first gear installed on it at a speed reduced in 3 steps. The reduction ratio is 152.51.
The cam disc actuates the flap limit switch. The bevel gears, at the end of the cam disc shaft rotate the flap position transmitter at 1:1 speed.
From the front side of the gear box is protruding the output shaft which is connected to No. 1 torque tube at both ends.
On the output shaft protruding to the right is installed a sprocket which is connected to the mechanical stop mechanism through chains.

B. Flap Mechanical Stop

The mechanical stopper is installed on the ceiling of the hydraulic compartment. It stops the flap positively in case of failure of the flap limit switch or if the flap is travelled too much by means of the flap emergency handle.
If the stopper screw is rotated by the sprocket and chains, the sliding nut moves to the left or to the right, placing the sliding nut in contact with the stopper assembly.
Shock absorbing rubber is provided on the stopper assembly.

C. Torque Tube

The torque tubes are made of 1"ø stainless tube. 5 of them are provided on each wing, connected together with chain couplings or flange universal couplings. The chain couplings are used where the torque tubes are connected in a straight line, and the flange universal couplings are employed where directions are changed.

Torque tube		Coupling
No. 1	Both ends	Chain
No. 2	"	Universal
No. 3	"	Chain
No. 4	"	Universal
No. 5	"	Chain

On the midway of the torque tube is provided a bakelite bracket to avoid its swinging motion. The screw jack is connected to the bevel gear box with a spline joint.

D. Connect the torque tube between screw jacks.

E. Set the counter gauge. After adjusting B, C and D rollers for No. 1, No. 3, No. 4 and No. 6 rails so that the flap is flush with the wing contour, adjust rollers for No. 2 and No. 5 rails.

F. Lower the flap taking the inboard side stopper of No. 1 rail rear stoppers as datum until it comes in contact with "C" roller.

G. Connect the actuating torque tube between L.H. and R.H. flaps. The clearance between "C" roller and the stopper shall be less than 0.5mm.

H. Adjust the side rollers "E" for both inboard and outboard flaps.
Inboard side clearance for No. 2 and No. 5 +0.5 to 1.0mm
Outboard side clearance for No. 2 and No. 5 +0.5 to 1.0mm

(2) Adjustment of Flap Actuating Mechanism

A. Adjustment of Gear Box Limit Switch (Fig. 7-40)

(a) Set L.H. and R.H. inboard flaps to 0 on the counter gauge.

(b) Adjust the attachment of the cam and the limit switch so that the up limit switch of the gear box is turned off when the fla is up at 0° and the down limit switch is turned off when the flap is down at 34° to 35°.

B. Adjustment of Mechanical Stop Mechanism (Fig. 7-41)

(a) With the flap up and the mechanical stopper in contact, rotate the sprocket towards the down side by 4±0.5 teeth.

(b) Actuate the mechanical stopper while the flap is down. Then, check the clearance between the flap roller and the rail stopper. If there is no clearance, adjust the nut of the mechanical stopper.

C. Adjustment of Over Travel Switch

(a) With the flap up at 0°, adjust the adjusting nut so that the clearance ⟨1⟩ is 1 to 2 mm.

(b) With the flap down and the mechanical stopper in contact, protrude the bolt by 2 to 3 mm and lock it.

(3) Tolerances

1. Misalignment between the flap : Chordwise $^{+0}_{-3.0}$mm
trailing edge and the wing contour : Vertical ±1.5mm

2. Inboard flap and outboard flap : 7.0 to 13.0mm

3. Play of flap trailing edge (both inboard: Max 4.0mm
and outboard)

D. Flap Asymmetry Test Switch

This permits electrical check of the asymmetry circuit. This should not be used to determine whether the system comes into action at 1° to 3.5° of the flap angle difference.

(2) Operation

The asymmetry system operates on the mechanical functions and the electrical functions.

The detector consists of 3 cam plates installed on the same shaft and the corresponding limit switches.

The cam lobes of the 3 cam plates are located 120° apart from each other. Consequently, if the cam shaft makes one rotation, each cam actuates the limit switch for 120°.

On the other hand, on the leading edge of the outboard flap is installed one end of a cable while the other end drives or is driven by a drum installed on the wing trailing edge. The cam shaft of the asymmetry detector, connected to the rotating shaft of the drum, detects the amount of rotation (flap angle) of the drum.

The detectors for the L.H. and R.H. flaps are connected electrically and cut off the electrical circuit to the selector valve and light the asymmetry indicating light (red) in the cockpit when the L.H. and R.H. flap angles become asymmetric (disturbing the limit switch actuating sequence of the cam lobes).

(3) Adjustment of Flap Asymmetry Detection Mechanism (Fig. 7-47)

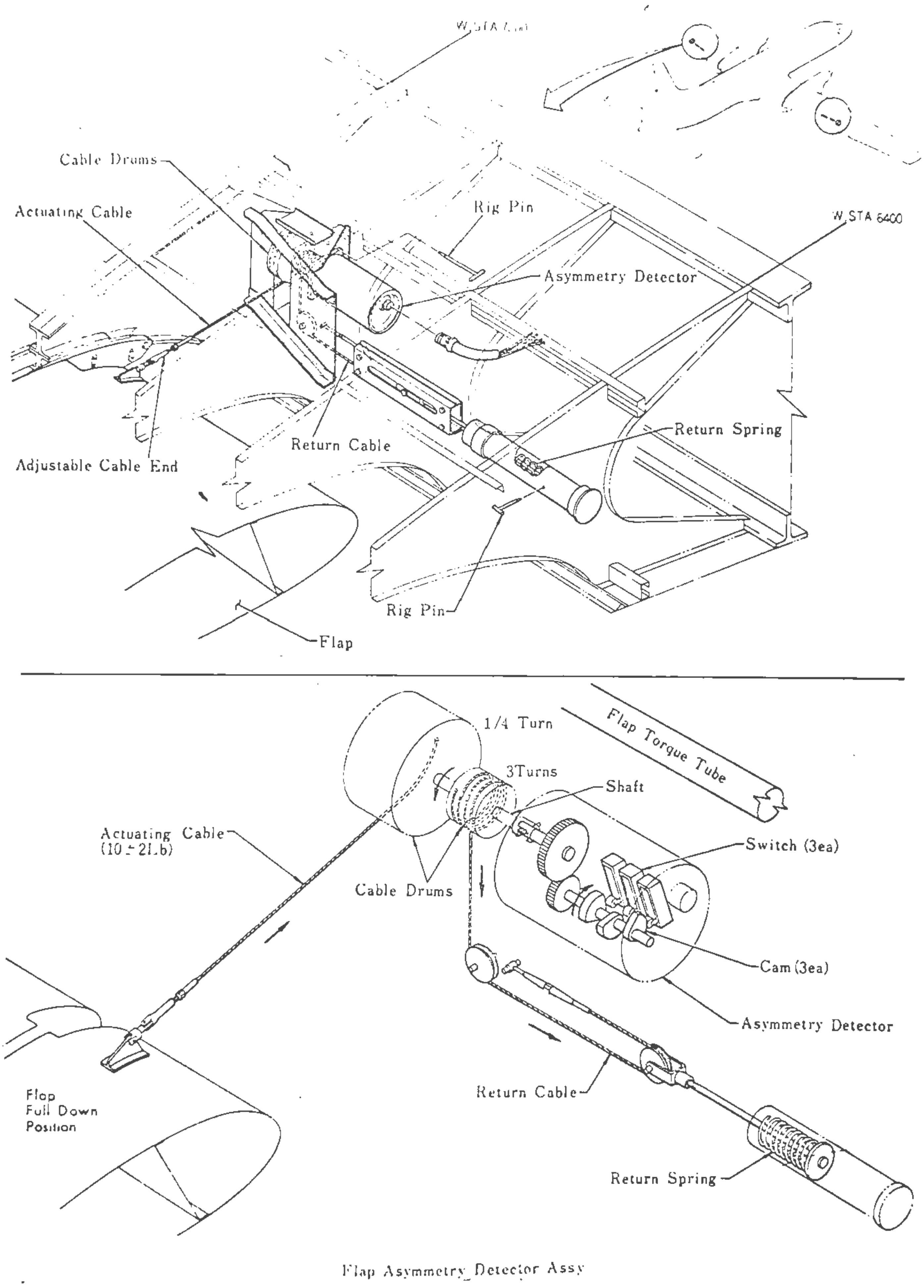
A. Fix the outboard flap so that the clearance between the rear stopper and the upper rear part of the carriage ("C" roller) is 21.5 mm (Flap angle 34°).

B. Fix the rig pin in the cable drum.

C. Compress the return spring to fix the rig pin.

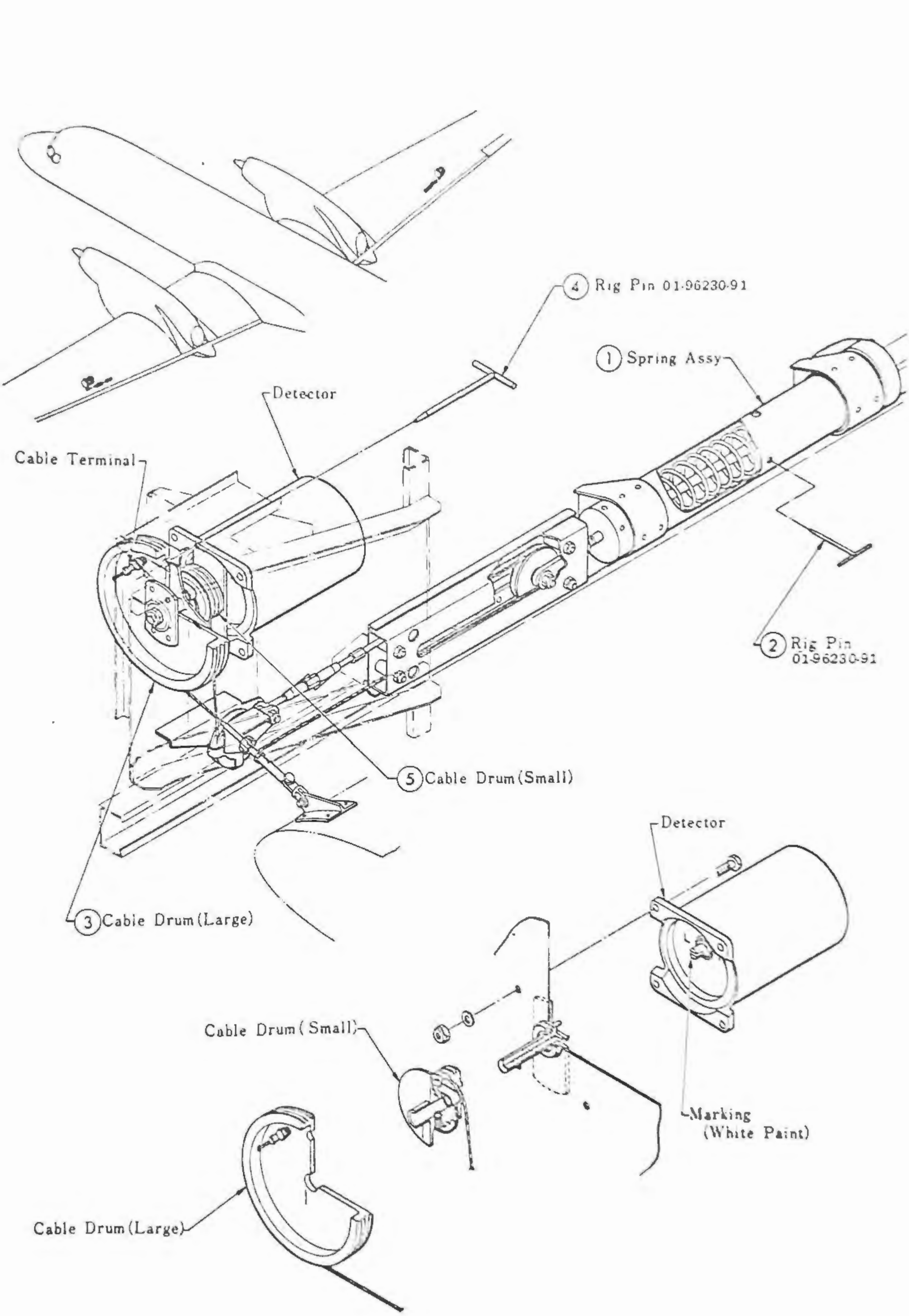
D. Adjust the terminal fitting so that the position of the pulley in the sliding groove for attachment is within the specified limits and then lock it.

E. Wind the cable around the drum (small) by 3 turns, wind it around the drum (large) by 1/4 turn, adjust the cable length by means of the turnbuckle and terminal, and lock it. Never tighten the cable until the spring washer can be seen from the spring washer position inspection hole.



Flap Asymmetry Detector Assy

Figure 7–47



Wing Flap Asymmetry Protection System Rigging

Figure 7—48

7.9 Gust Lock System

7.9.1 General (See Figs. 7-50 and 7-51)

If the gust lock lever on the right hand side of the pedestal in the cockpit is moved forward, pins enter the gust lock quadrants for the control surfaces, fixing them at their neutral positions, respectively.

The lock mechanism locks the aileron with a gust lock quadrant at the lower part of the torque tube in the flight control compartment, the rudder with a gust lock quadrant at the rudder torque tube and the elevator with a gust lock quadrant at the elevator torque tube.

The control surfaces can be locked even though they are not in their neutral positions. The lock pins are engaged and the control surfaces are locked if the control surfaces are moved towards their neutral positions while the lock levers are placed in the lock positions.

Between the gust lock lever and the low stop lever is provided an interlocking mechanism.

7.9.2 Control Lever and Locking Mechanism (See Fig. 7-51)

(1) Composition

A. Gust lock
B. Gust lock lever
C. Cable system

A. Gust Lock

The three control surfaces are provided with the same gust locks 1 ea. The gust lock consists of a gust lock assembly with a knock pin and a gust lock quadrant.

B. Gust Lock Lever

The gust lock lever is located on the R.H. side of the center pedestal in the cockpit and it has two positions, i.e., "ON" and "OFF". On the rotating shaft of the lever is provided the interlocking lever which does not permit the low stop lever to move to "FLIGHT" when the gust lock is "ON". On the other hand, the gust lock can not be engaged if the low stop lever is in "FLIGHT".

C. Cable System

Below the center pedestal is located a quadrant which is actuated by the gust lock lever through an idle and two rods. Two 3/32" cables, i.e., lock cable and unlock cable are connected to this quadrant. This cable is separated into two sets at a triangular link fitting, one set running to the aileron gust lock. The other one is separated again into two sets at the cable end, being connected to the elevator and the rudder gust locks, respectively. The unlock side cable has always less tension than the lock side.

(2) Lock Mechanism

A push-pull rod is attached to the gust lock lever, actuating a quadrant at its end (below the floor) to transmit the lever movement to the cable. This push-pull rod is installed with 8° overtravel in relation to the gust lock lever. As the rod with the interlocking lever moves ahead of the rotating shaft of the gust lock lever, the gust lock lever moves forward abruptly, accomplishing the over center locking.

Under the above conditions, the control surfaces are locked against the unlock spring, the over center lock of the locking mechanism in disengaged automatically if the lever is pushed hard rearward or the cable is cut, drawing back the lever by the unlock spring of the gust lock to be unlocked.

Even if the gust lock is in the lock position, there is play at the knock of each gust lock. Consequently no excessive force is applied to the mechanism of the control system. Under this condition, each knock pin enters the hole of the corresponding quadrant and is locked if the pedal, control column or aileron control wheel is placed in their neutral positions, respectively.

7.9.3 Procedures for Gust Lock System Adjustment (See Fig. 7-55)

(1) Neutral Fixed Points (4 locations)

Number	Fixed to	Location	Fixing method
1	Quadrant	Qaudrant	Rigging pin
2	Aileron gust lock	Gust lock Ass'y	"
3	Rudder gust lock	"	"
4	Elevator gust lock	"	"

(2) Adjusting Procedures

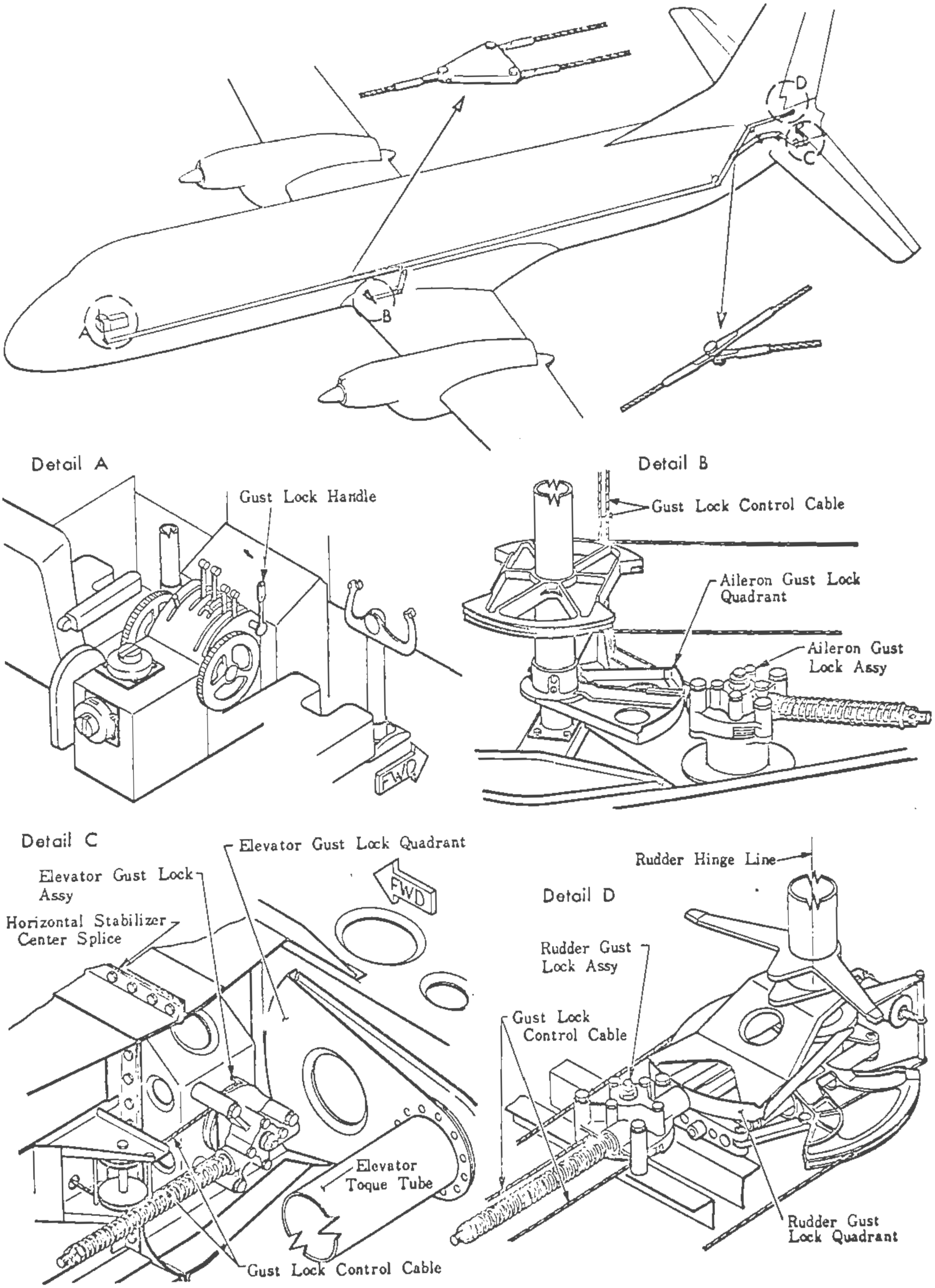
A. Place the gust lock levers in the "UNLOCK" positions.

B. Fix numbers 1, 2, 3, and 4.

C. Adjust the cable in accordance with the tension chart in Fig. 7-56.

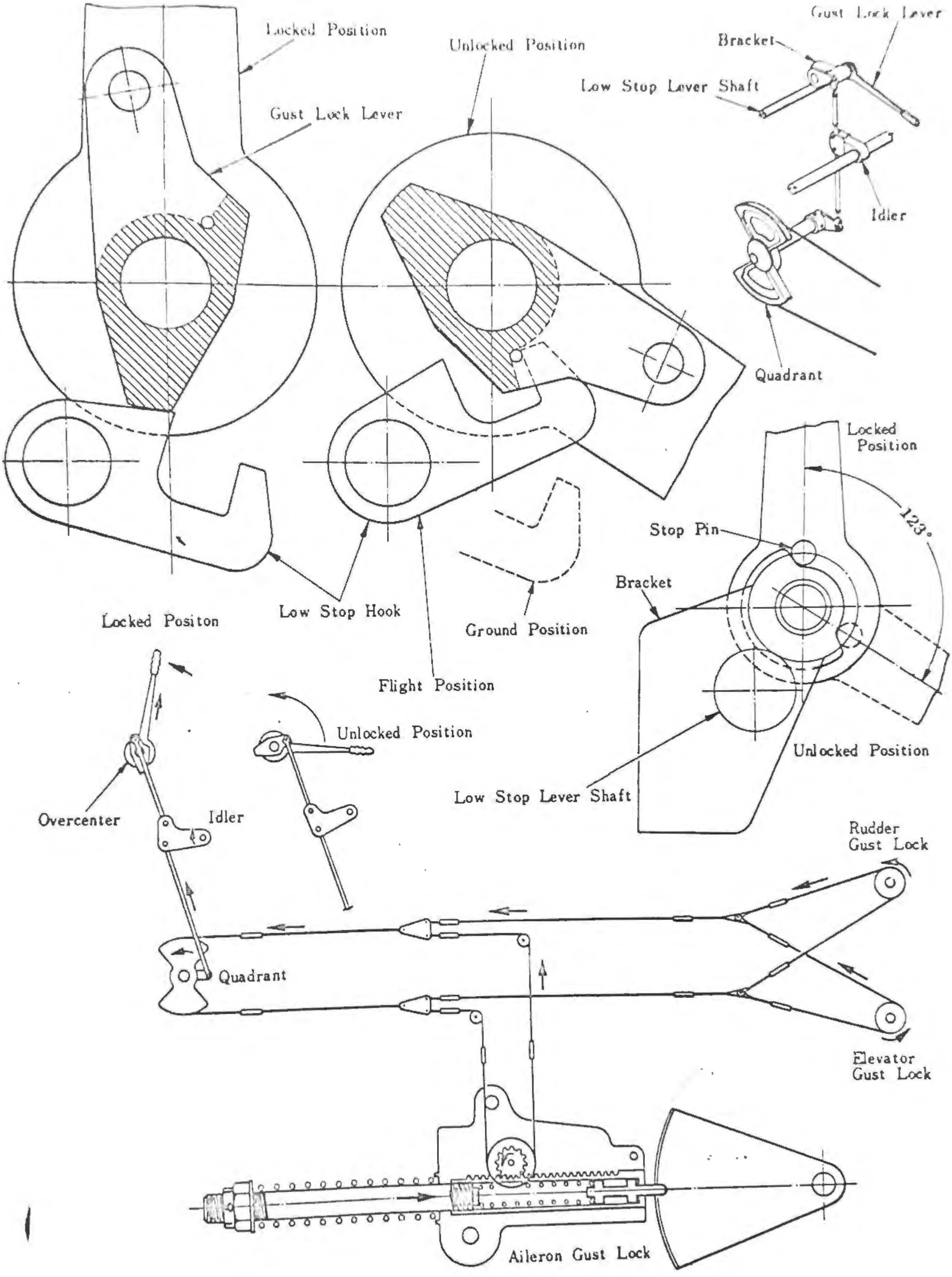
D. Dislocating the three control surfaces from their neutral positions, place the gust lock lever in the "LOCK" positions.

E. More each control surface and make sure that the knock pins enter the quadrant holes and the control surfaces are locked.



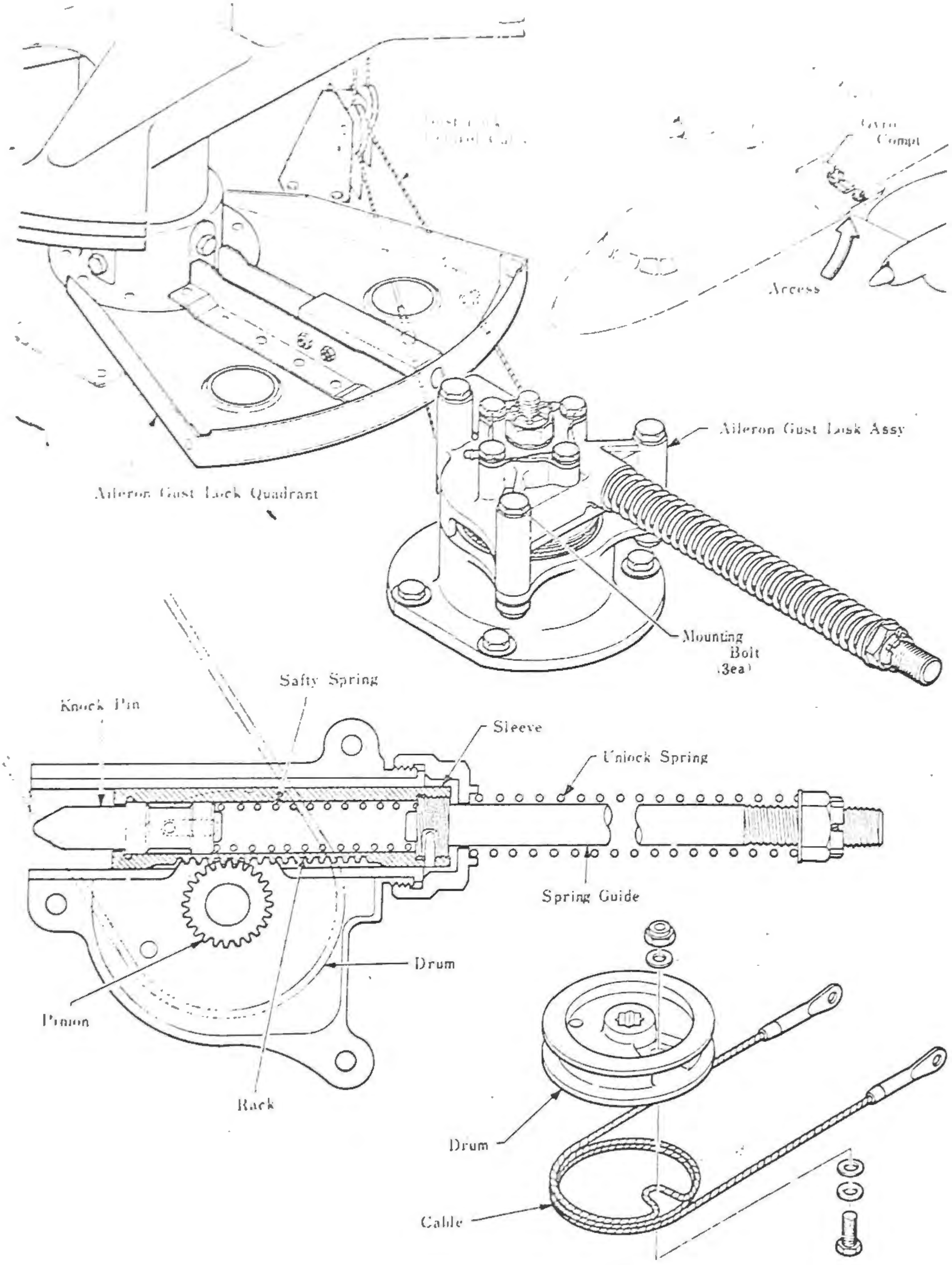
Gust Lock System

Figure 7–49

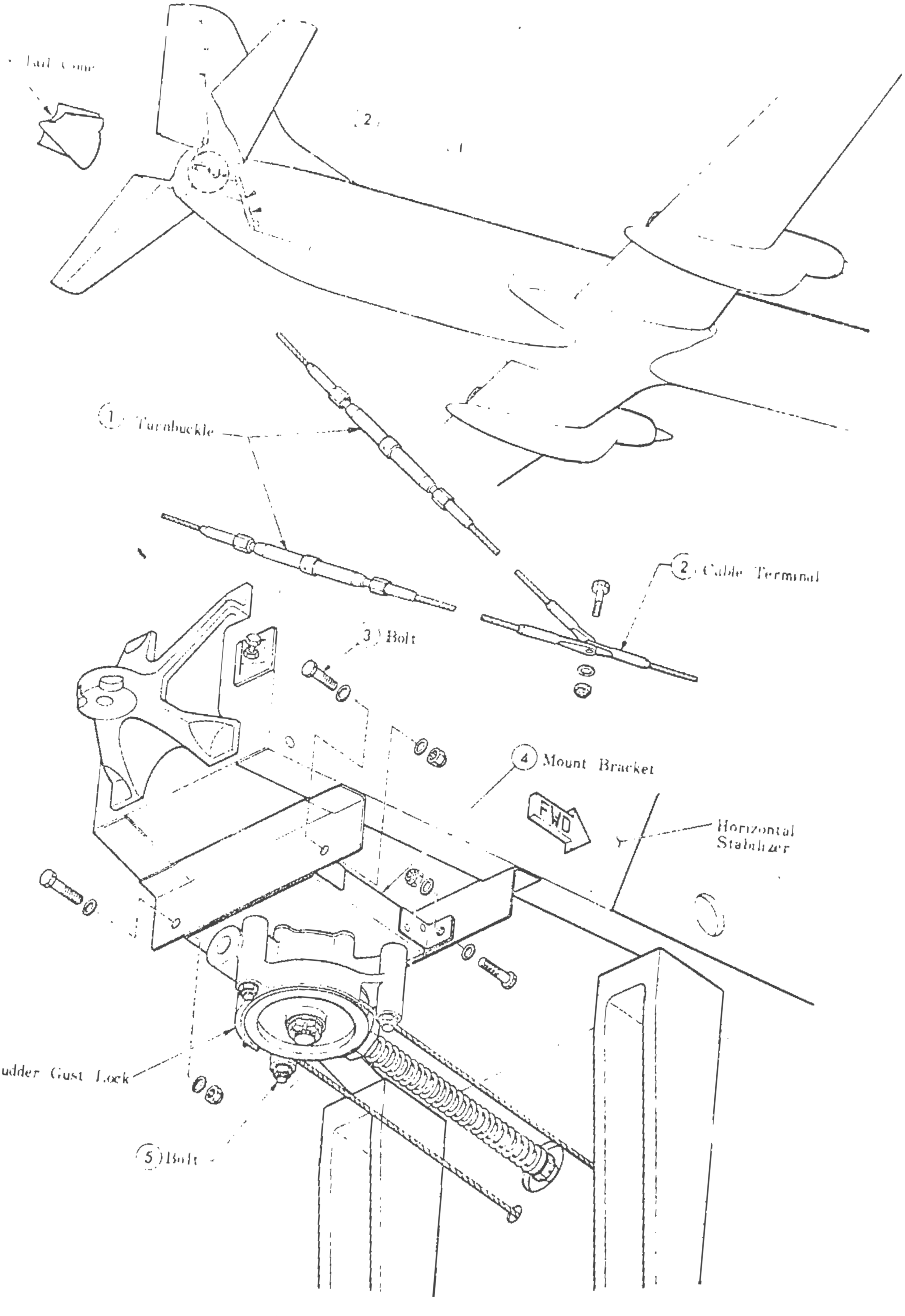


Gust Lock System

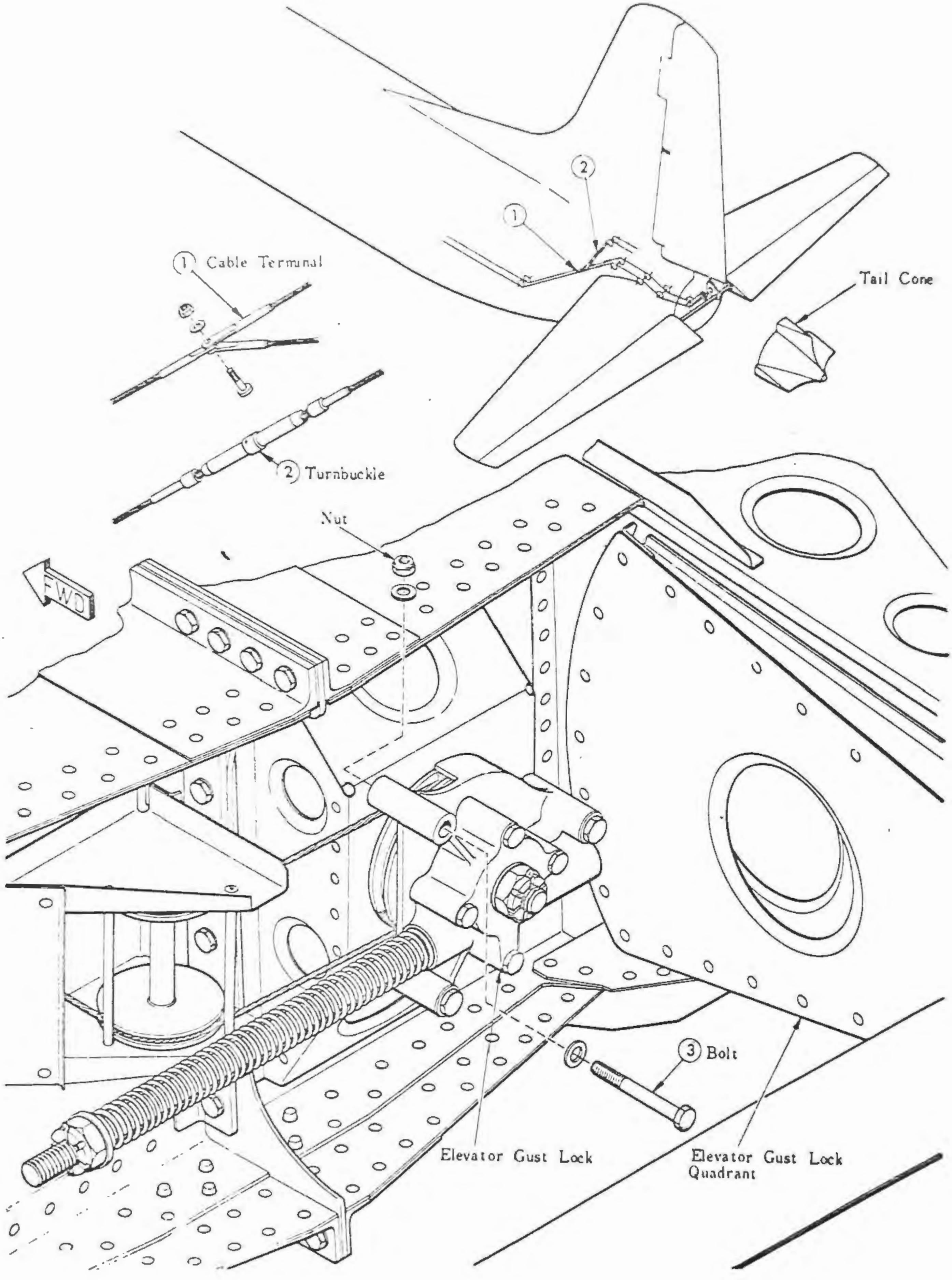
Figure 7–50



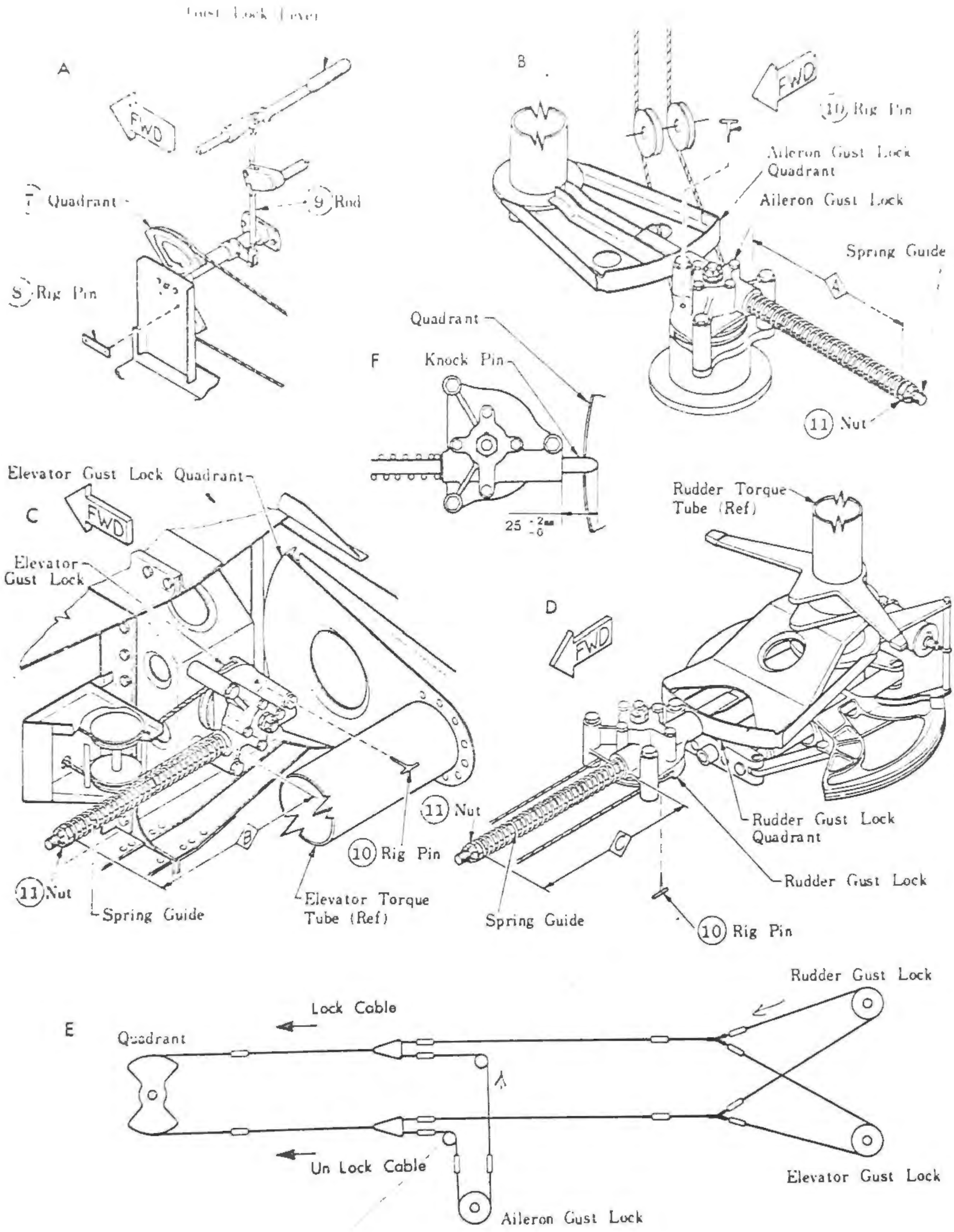
Aileron Gust Lock
Figure 7–51



Rudder Gust Lock
Figure 7-52

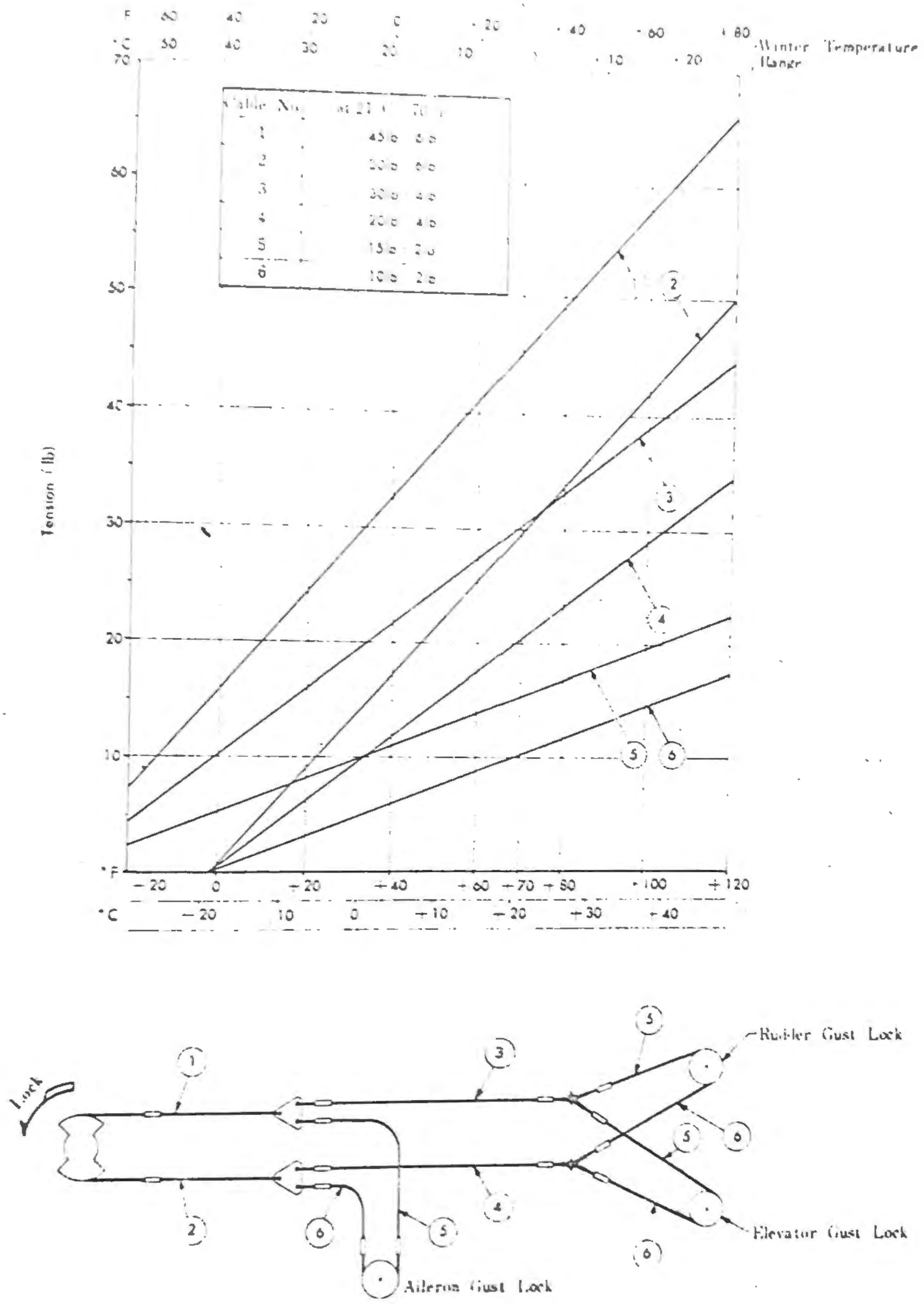


Elevator Gust Lock
Figure 7–53



Gust Lock System Rigging

Figure 7-54



Gust Lock Control Cable Tension Chart

Figure 7-53

Chapter 8 INSTRUMENT SYSTEM

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Chapter 8 INSTRUMENT SYSTEM

8.1 General

All the instruments for the YS-11 are installed on the main instrument panel, L.H. side panel and overhead instrument panel arranged in the cockpit. These instruments consist of air data instruments, gyro instruments, liquid quantity instruments, pressure instruments, temperature instruments, engine instruments, navigation instruments and miscellaneous instruments.

8.2 Cockpit Arrangement

8.2.1 General

In the cockpit are arranged the following instrument panels:

(1) Main Instrument Panel

On this instrument panel are installed the navigation instruments, engine instruments, instruments for fuel, instruments for the hydraulic system and air data instruments.

(2) Overhead Panel

On this panel are installed the voltmeter, ammeter, temperature indicators, switches and indicating lights.

(3) Side Panel

On this panel are installed the instruments for air conditioning system, switches, indicating lights and levers.

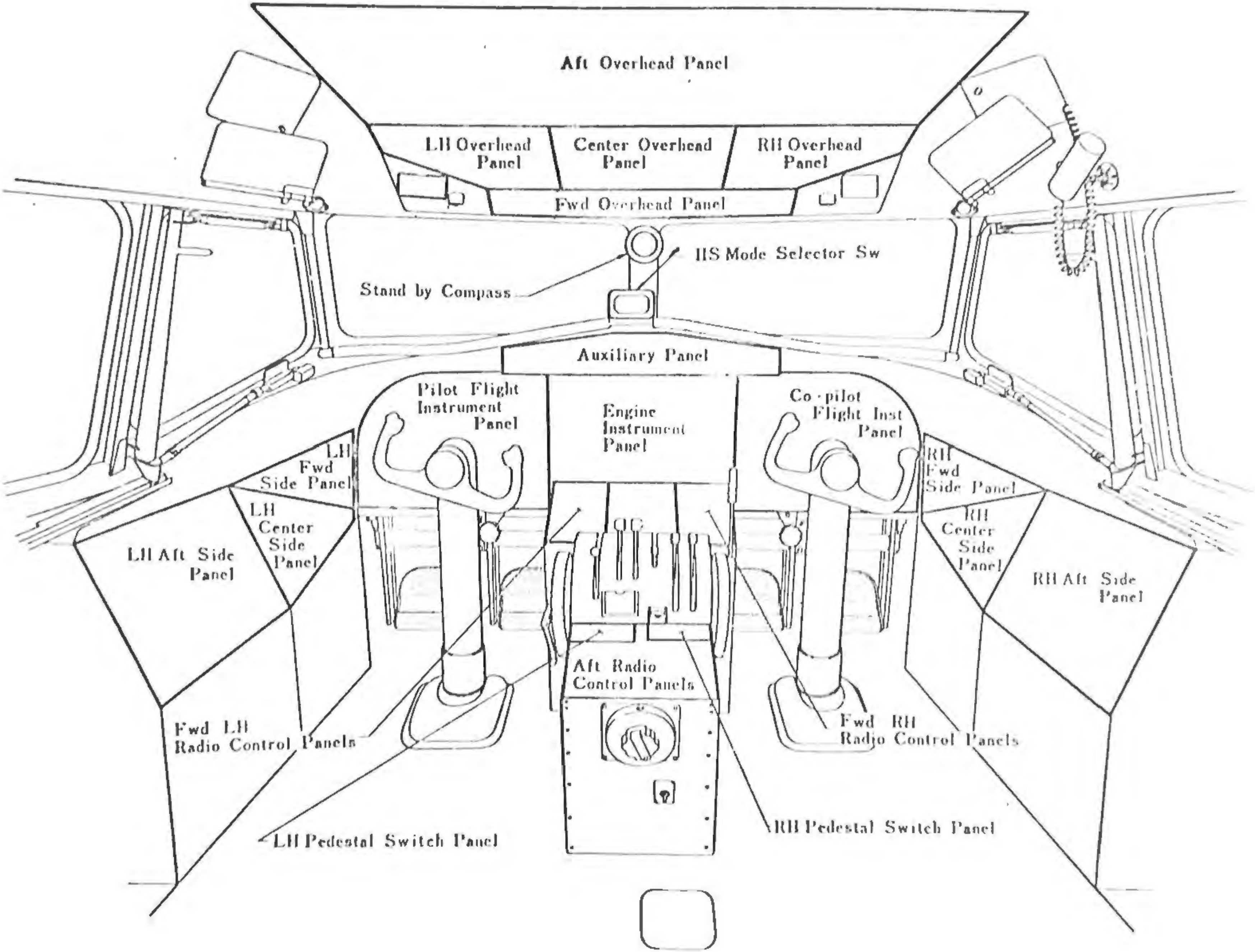
(4) Auxiliary Panel

On this panel are installed the switches and indicating lights for propellers and fire extinguishers.

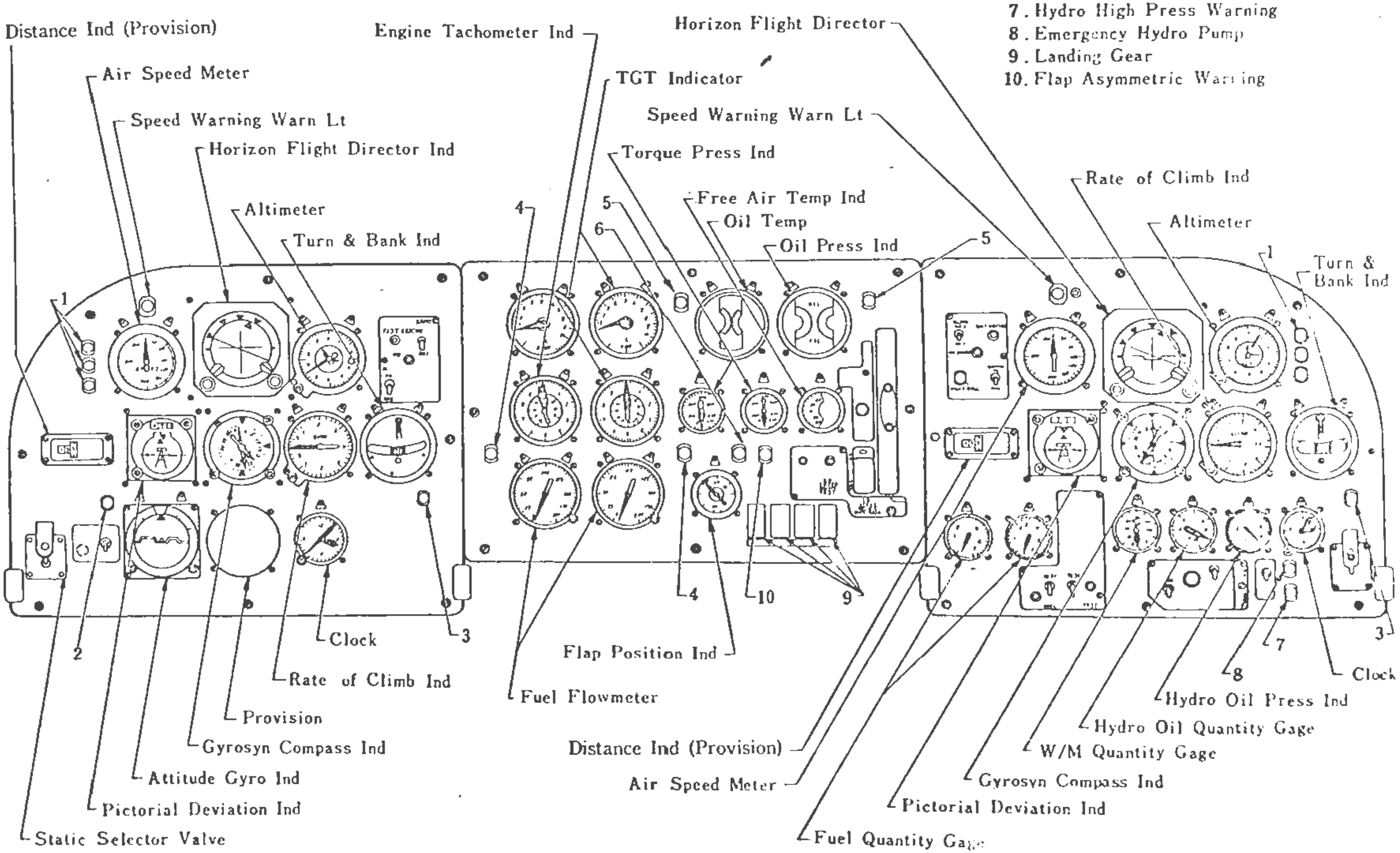
8.2.2 Main Instrument Panel

The main instrument panel is fixed to the mounting frame with Camloc fasteners and the frame,in turn, is fixed to the airframe with shock absorbers, 4 in the upper and lower sections and 2 in the forward and rear sections. These absorbers absorb shocks, protecting the instruments. The brackets attached to the main instrument panel together with the fittings on the frame serve as hinges. When the panel is pulled out forward, it is held in position by supports.

Instruments are removed from the back side of the panel, after removing 4 screws fixing the panel to the frame. However, the following instruments can be removed from the front side of the panel, only after loosening clamp holder screws:



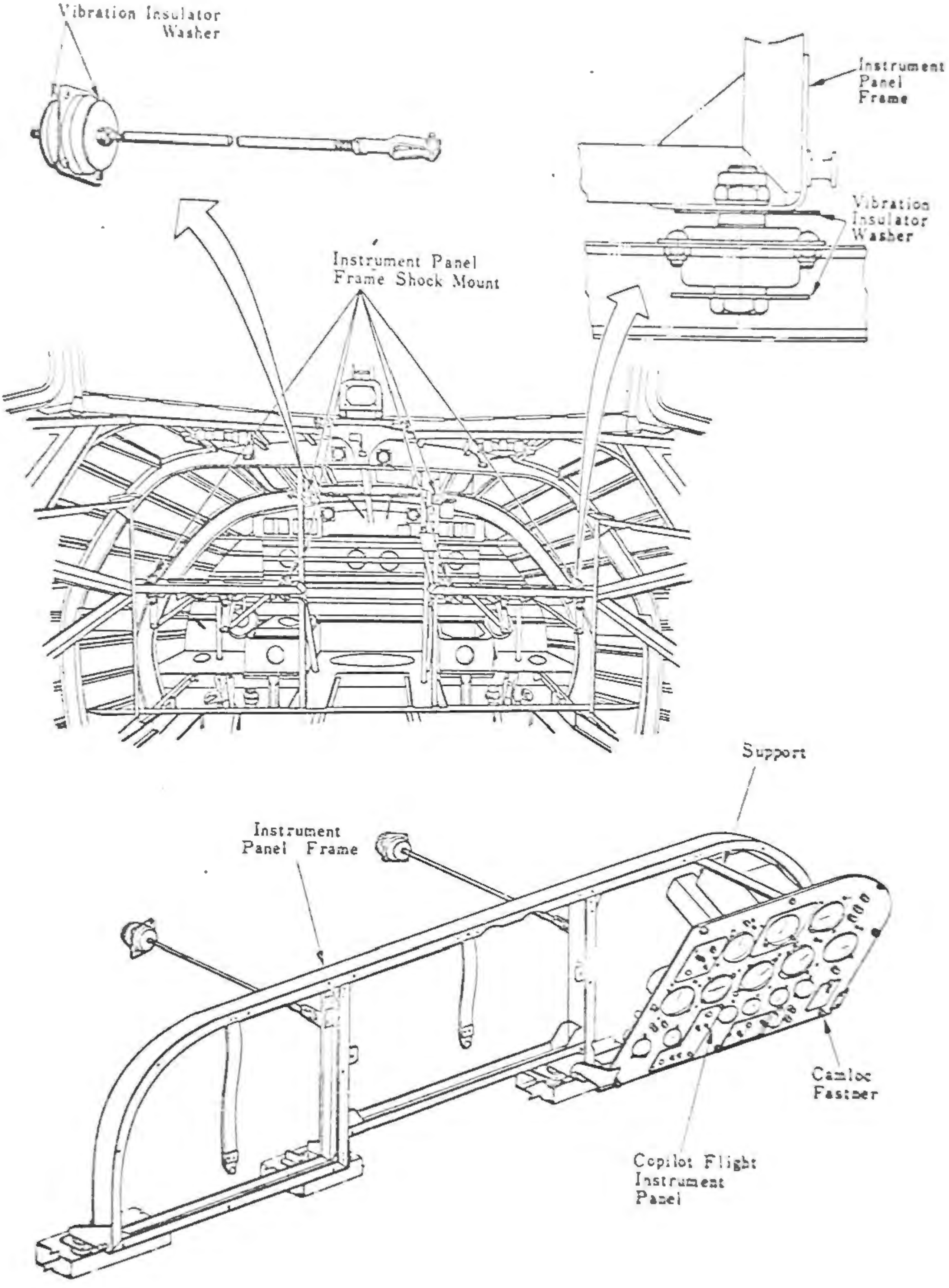
Cokpit Instrument Panel Arrangement
Figure 8-1



Warning And Indicating Lamp

1. Marker Beacon
2. Anti Skid Warning
3. Power Failure Warning
4. Fuel Pressure Warning
5. Oil Pressure Warning
6. Flap Over Travel Warning
7. Hydro High Press Warning
8. Emergency Hydro Pump
9. Landing Gear
10. Flap Asymmetric Warning

Main Instrument Panel Assembly
Figure 8-2


Vibration Insulator Washer
Instrument Panel Frame
Vibration Insulator Washer
Instrument Panel Frame Shock Mount
Support
Instrument Panel Frame
Camloc Fastner
Copilot Flight Instrument Panel

Pilot's Instrument Panel Installaion

Figure 8-3

(1) Fuel Flow Indicator

(2) Free Air Temperature Indicator

(3) Fuel Quantity Indicator

(4) Hydraulic Pressure Indicator

(5) Hydraulic Quantity Indicator

(6) Flap Position Indicator

8.2.3 Overhead Panel

The overhead panel consists of 5 panels which are fixed to the ceiling beams directly with fasteners. Only the aft panel can be opened downwards by means of hinges.

(1) Forward Overhead Panel

On this panel are installed the switch lights for exterior lighting system, start and ignition system, and fire extinguisher system.

(2) Center Overhead Panels

The switch lights and voltmeter for DC power source system are installed on its right hand side, the ammeter and switch lights for fuel control system in its center and the voltmeter and switch lights for AC power source system on its left hand side.

(3) Aft Overhead Panel

The light dimmer adjusting knobs for the cockpit are installed on its both sides and indicators, lights, switches etc. for wing & tail deicing system are installed on its center.

8.2.4 Side Panels

Each of the L.H. and R.H. side panels consists of the forward, center and aft panels, detachable by removing fasteners.

The speed warning bell is installed on the forward panel of the L.H. side panel; the nose steering handle, audio control and wiper speed control on the center panel and the O_2 demand regulator on the aft panel.

The landing gear emergency handle, lights for the door and switch lights for air conditioning are installed on the forward panel of the R.H. side panel; the instruments, for air conditioning, control panel, switches, lights and hydraulic by-pass lever on the center panel and the emergency flap handle, manual selector lever, O_2 demand regulator etc. on the aft panel.

8.2.5 Auxiliary Panel

The panel on which mainly switches and lamps are installed is attached to the frame with 4 screws.

On this panel are installed the switches and indicator warning lights for propellers and switch lights for fire extinguishers.

8.2.6 Other Equipment

On the center pedestal are located the control panel for electronic equipment, levers for power plant, trims for flight control surfaces and switches. In front of the pilot and the copilot is provided the deiced windshield glass and at its lower end are located the ILS mode selector and stand-by compass.

8.3 Air Data Instruments

8.3.1 Pitot Static Pressure System

The pitot system is a completely independent system, taking the dynamic pressure by means of the Pitot tubes. These tubes are located on the L.H. and R.H. sides of the airplane nose section and provided with heater for deicing. The pilot side Pitot tube provides dynamic pressure to the pilot side instruments and the copilot side Pitot tube provides dynamic pressure to the speed warning pressure switch in the electrical compartment through the shut off valve located on the R.H. side panel, as well as to the copilot side instruments.

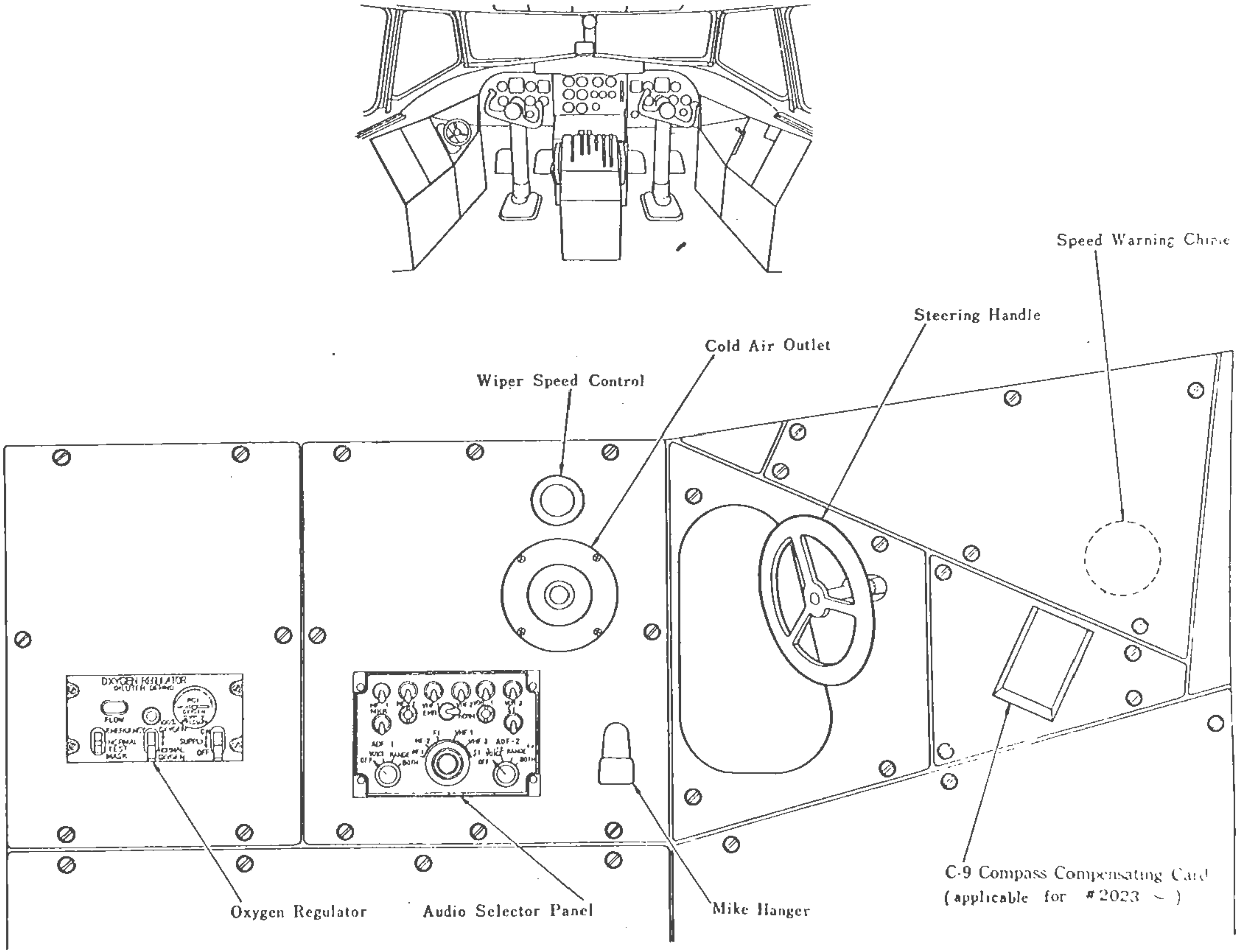
On the other hand, the static ports are located symmetrically on the L.H. and R.H. sides of the lower part of the fuselage aft of the entrance door.

The static ports are provided 1 ea. for the pilot, copilot and amplifier. The static port for the pilot is connected to the instruments for the pilot via the static selector valve located on the instrument panel for the pilot. The static port for the copilot is connected not only to the instruments for the copilot via the static selector valve located on the instrument panel for the copilot but also to the cabin pressure differential indicator via the shut off valve located on the R.H. side panel.

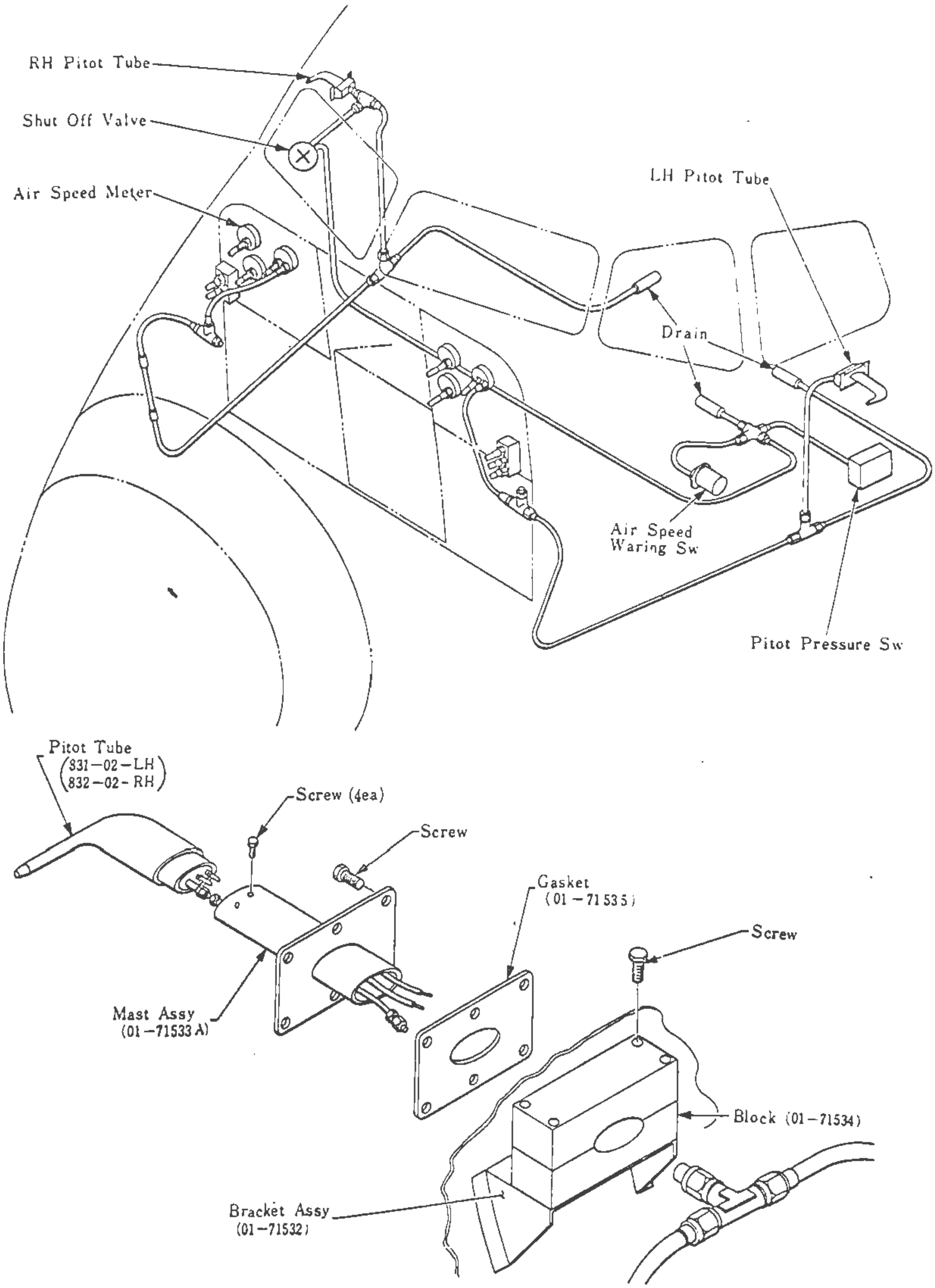
These ports are provided with heaters for deicing.

The static selector valves located on the main instrument panels for the pilot and the copilot are connected to a port for use in emergency and they can be switched to the emergency port if necessary.

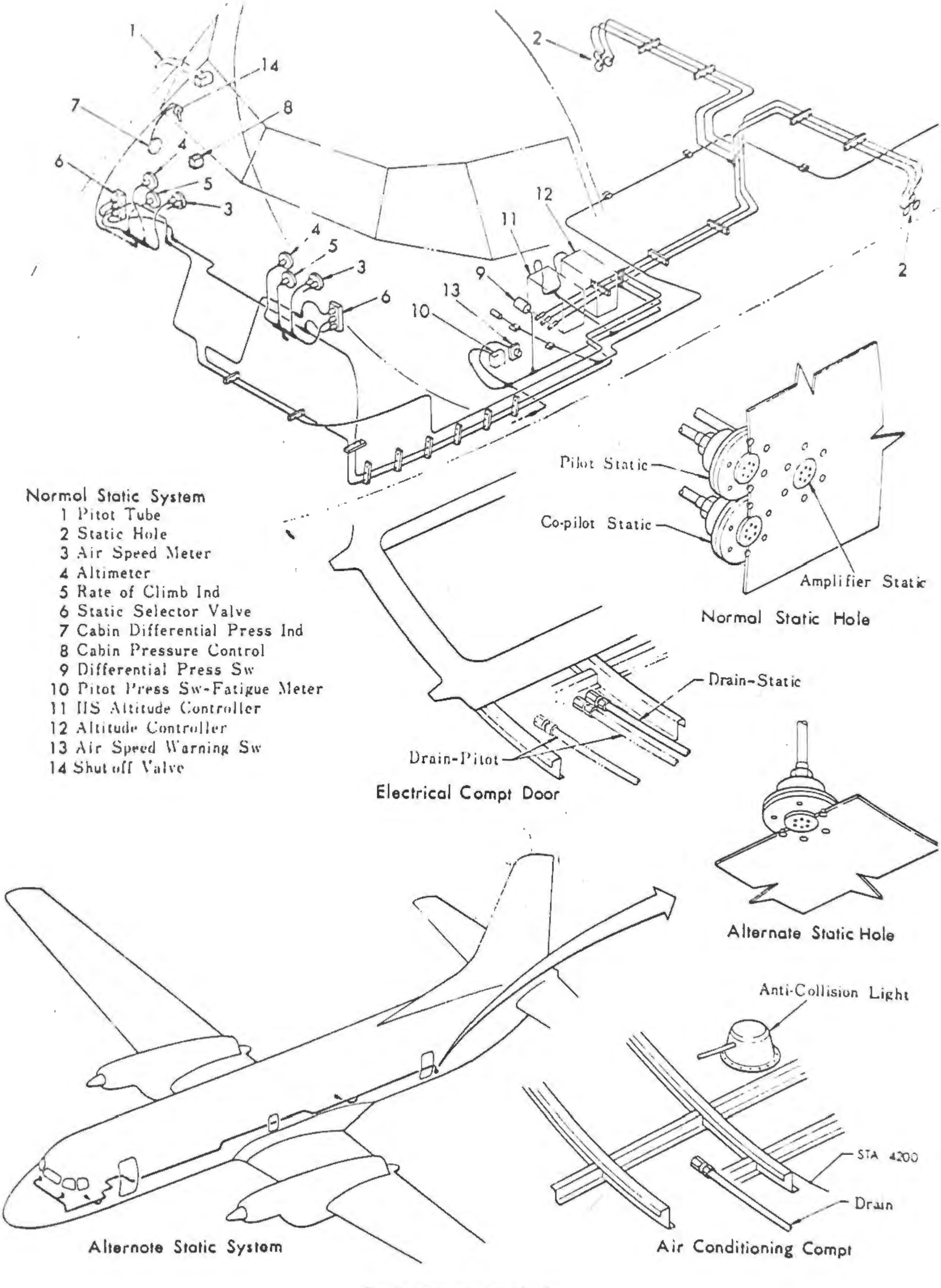
The amplifier port provides static pressure to the components in the electrical compartment. To check the Pitot tube leakage, a 300 Kt pressure is applied to it for 1 min. The leakage should not be more than 5 Kt. To check the static tube, a suction corresponding to 8,000 ft is applied to it for 1 min. The leakage should not be more than 3,000 ft.



LH Side Panel
Figure 8-5



Pitot Tube Installation
Figure 8-9



Normal Static System
1 Pitot Tube
2 Static Hole
3 Air Speed Meter
4 Altimeter
5 Rate of Climb Ind
6 Static Selector Valve
7 Cabin Differential Press Ind
8 Cabin Pressure Control
9 Differential Press Sw
10 Pitot Press Sw-Fatigue Meter
11 HS Altitude Controller
12 Altitude Controller
13 Air Speed Warning Sw
14 Shut off Valve

Normal Static Hole

Electrical Compt Door

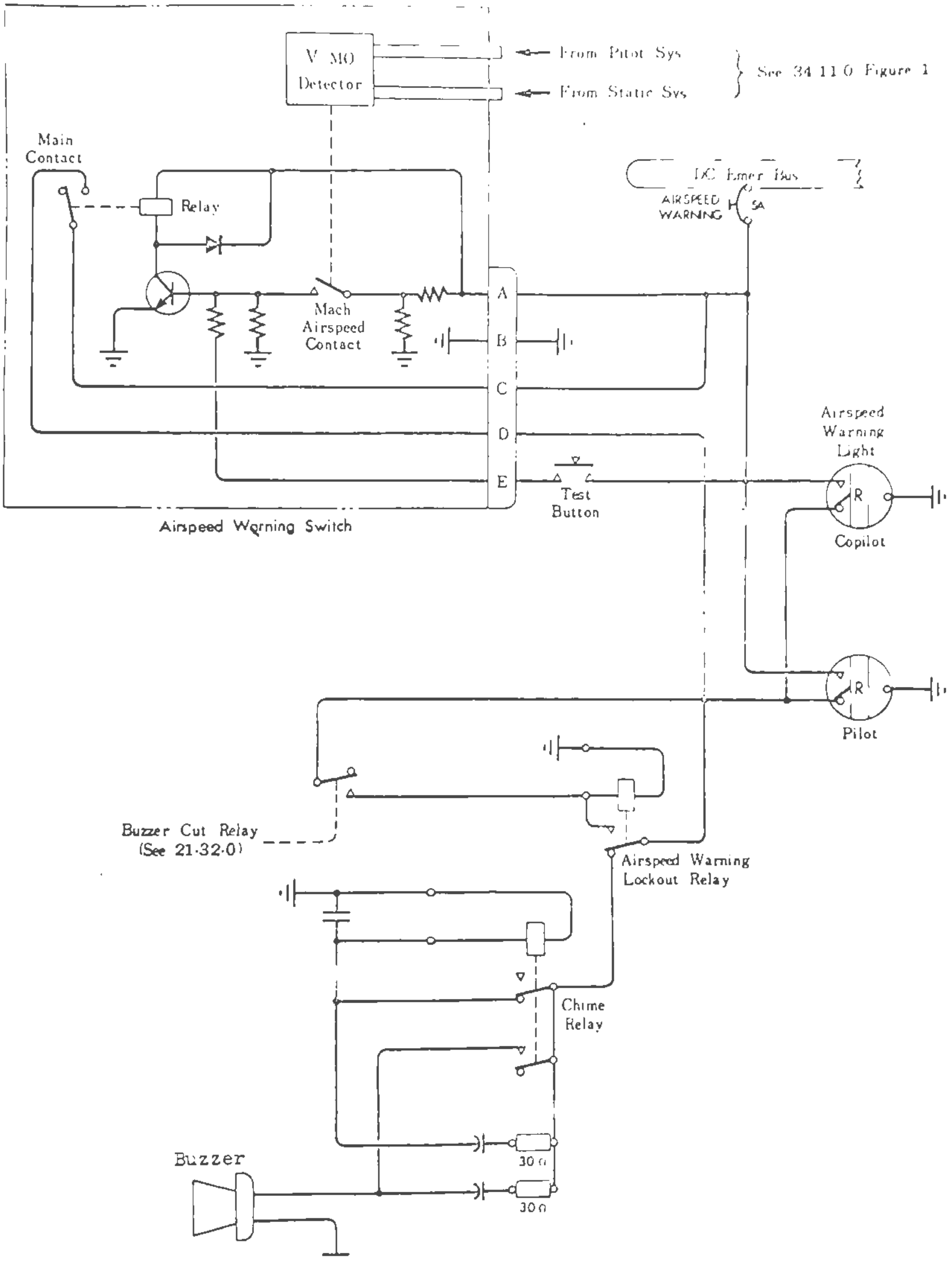
Alternate Static Hole

Alternate Static System

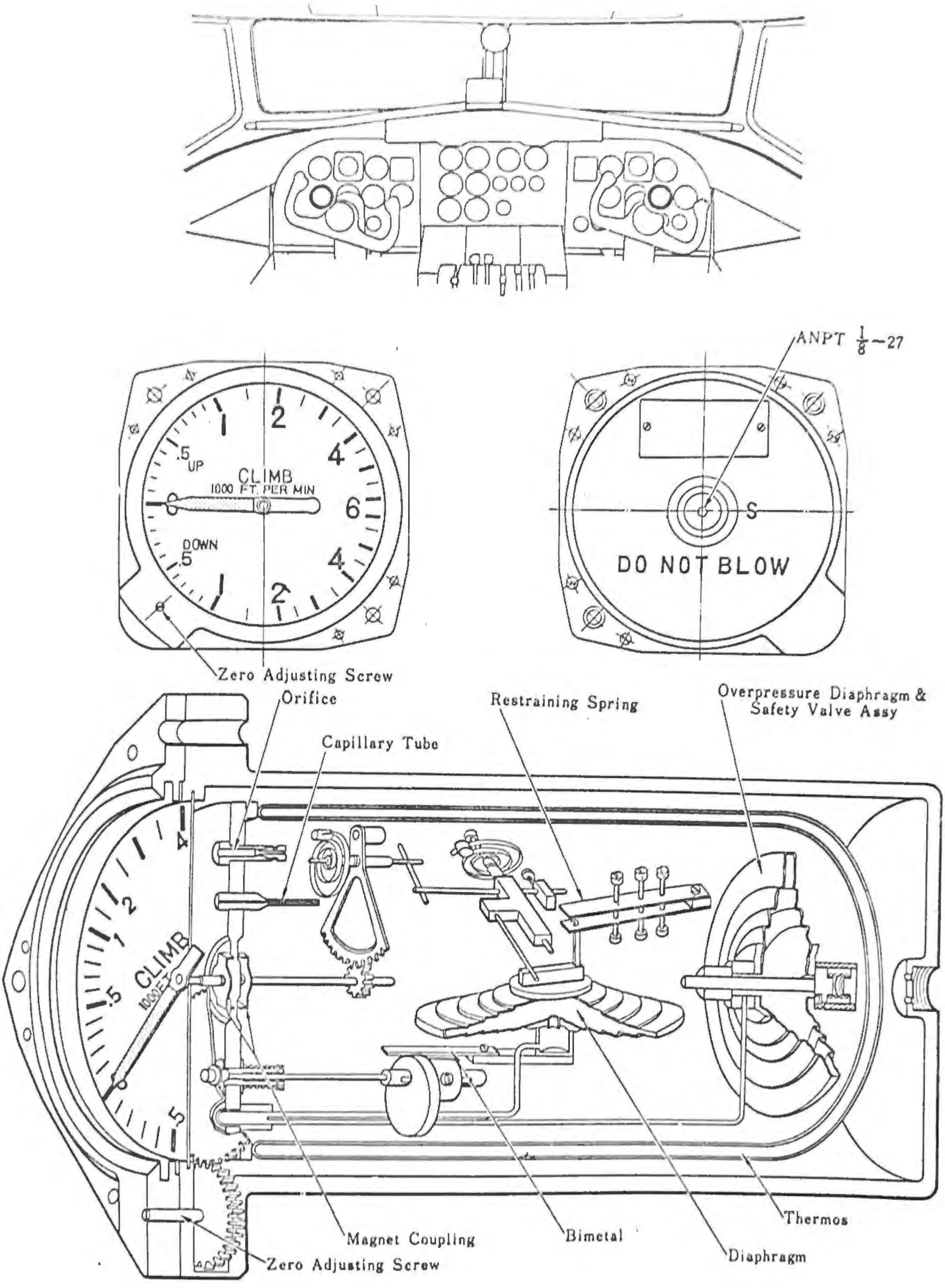
Air Conditioning Compt

Static System Installation

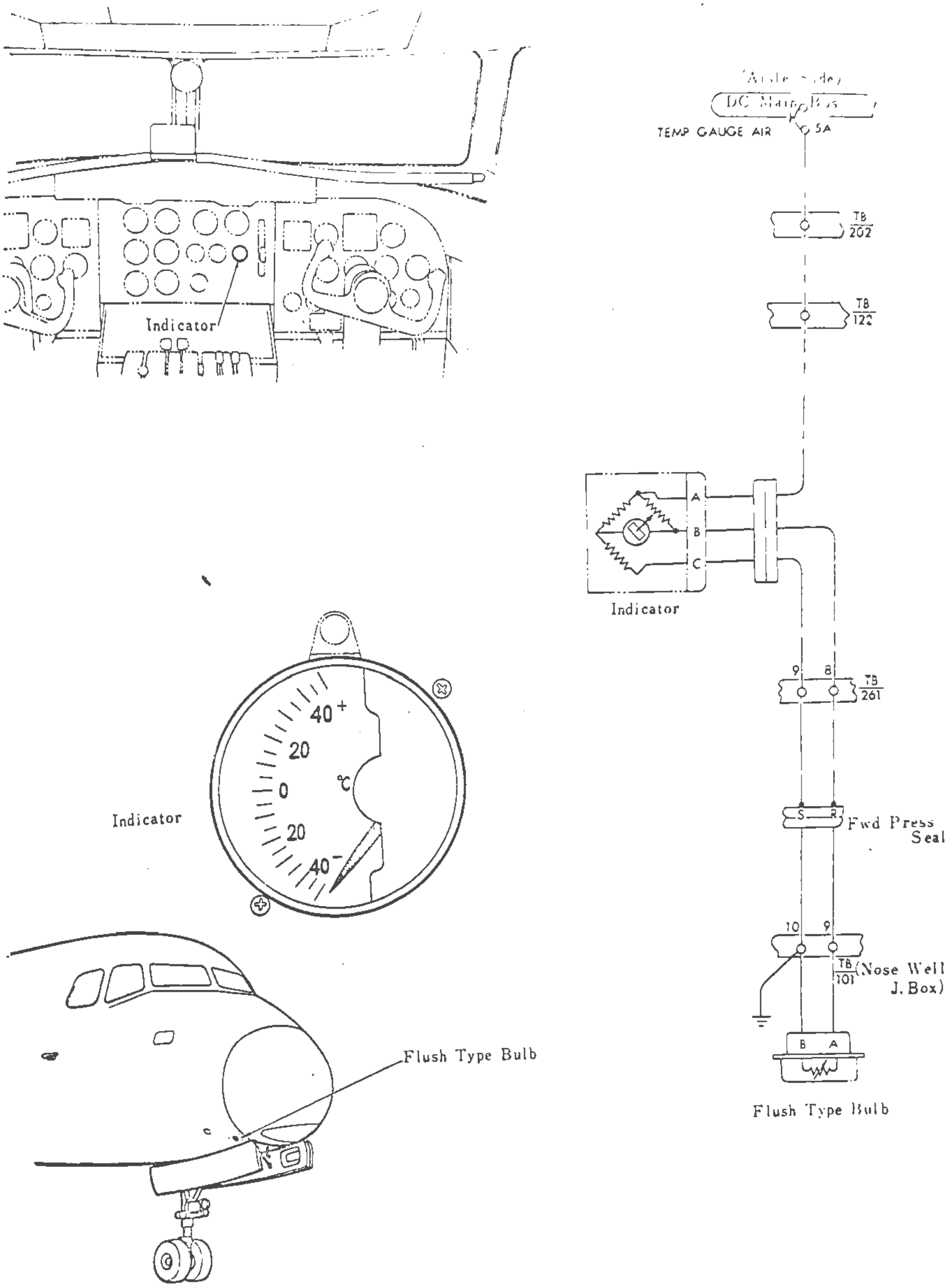
Figure 8-10



Airspeed Warning System Schematic
Figure 8-12

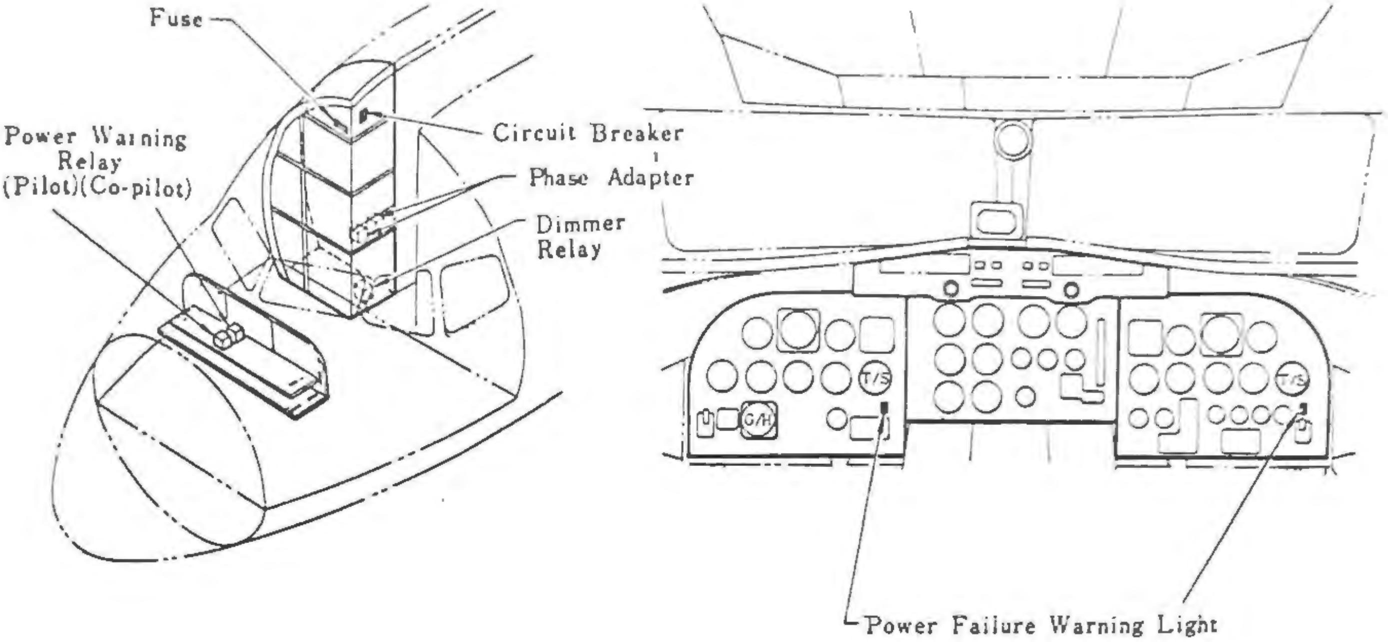


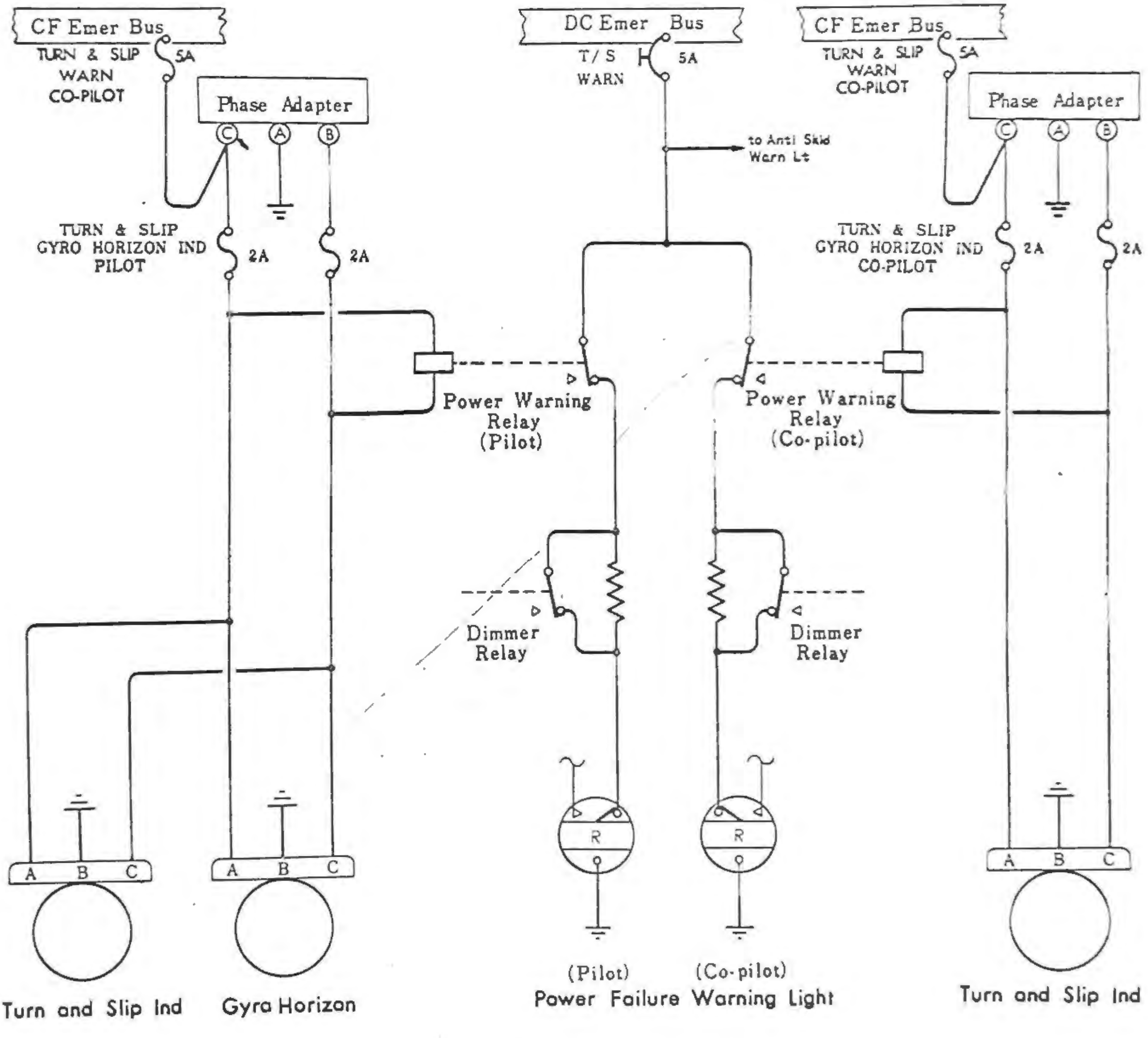
Rate of Climb Indicator
Figure 8-14



Free Air Temperature Indicator System

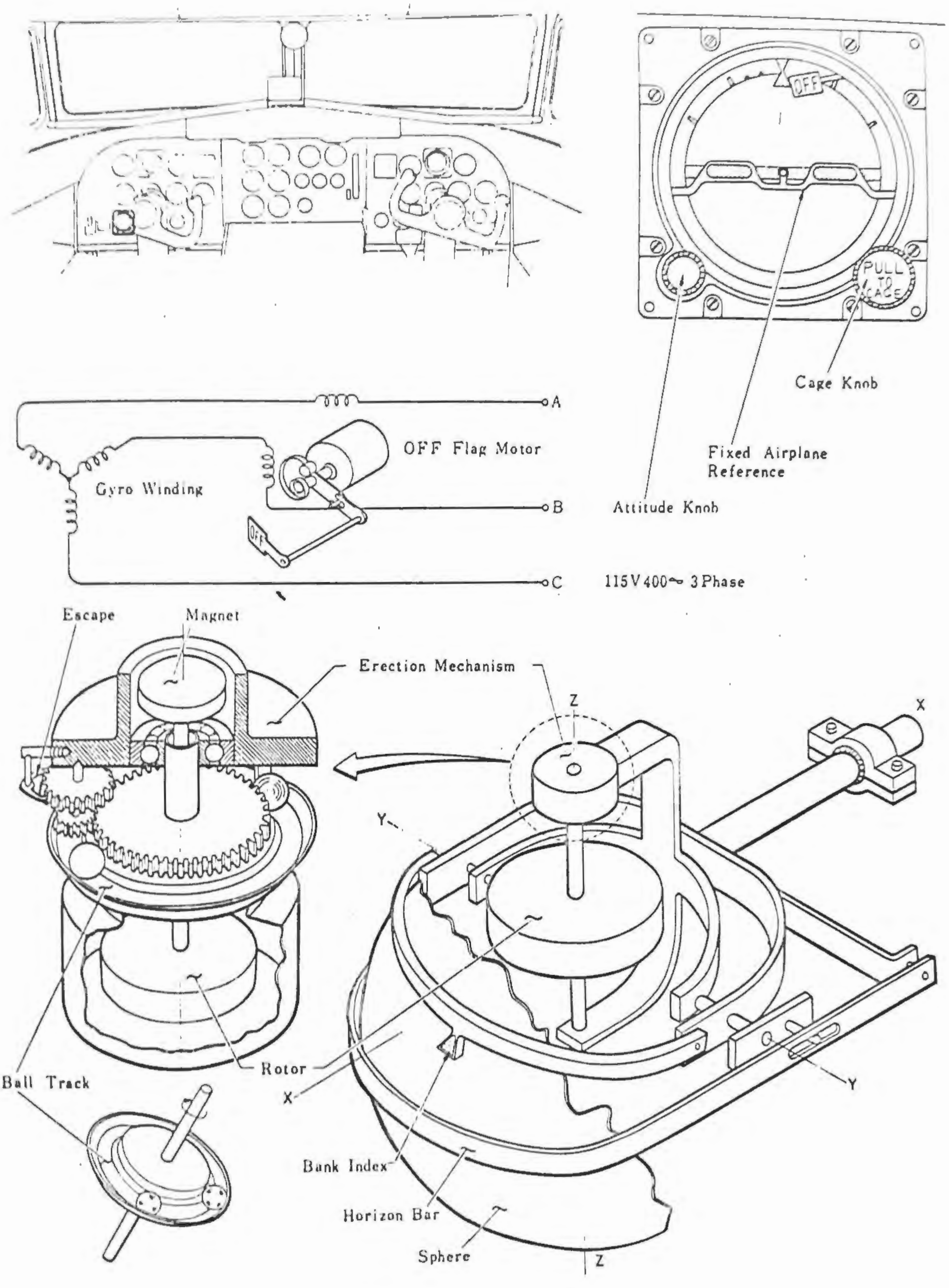
Figure 8–15


Fuse
Power Warning Relay (Pilot)(Co-pilot)
Circuit Breaker
Phase Adapter
Dimmer Relay
T/S
G/H
T/S
Power Failure Warning Light

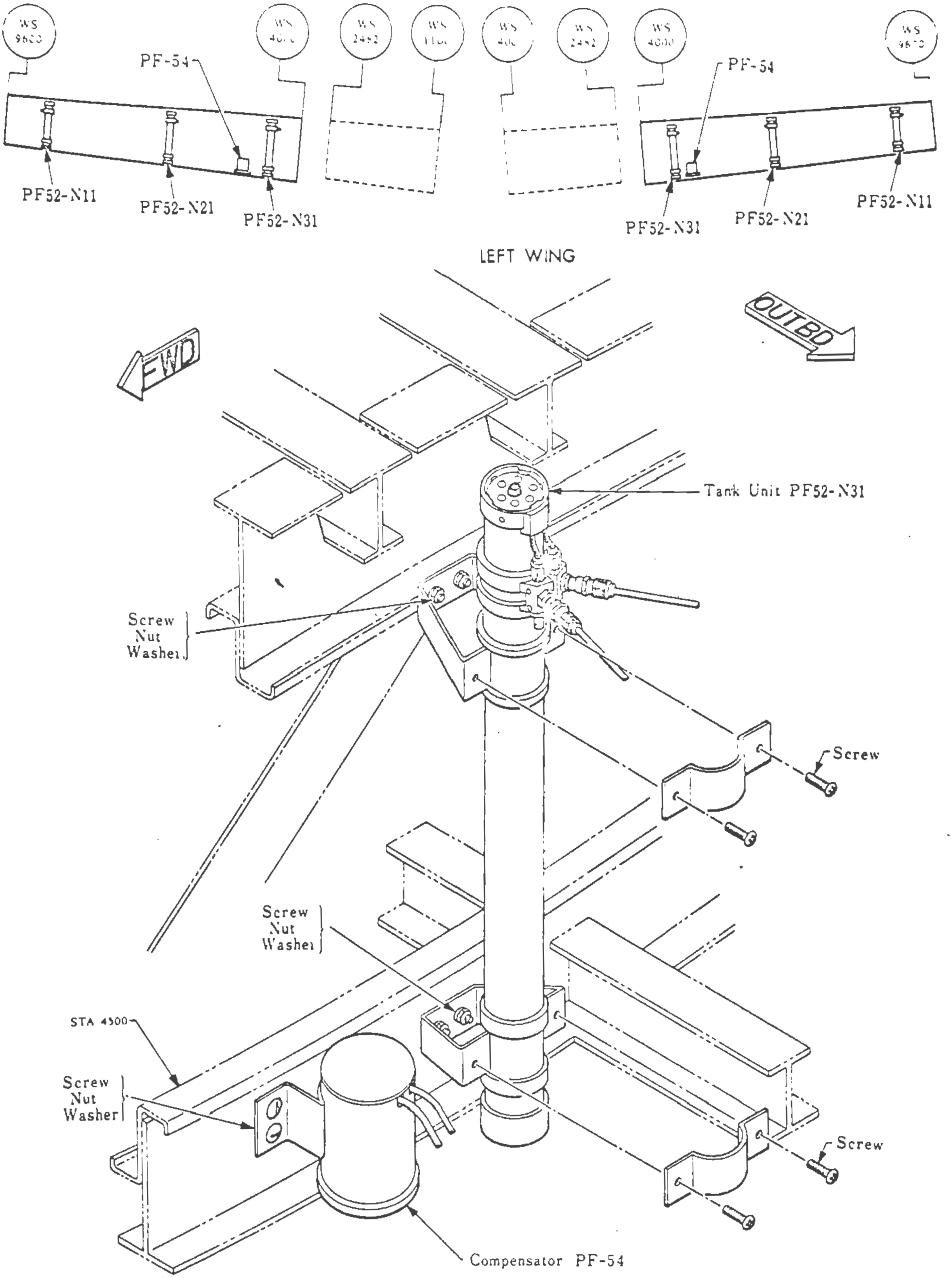


Gyro Instruments Power Schematic

Figure 8–16



Attitude Horizon Indicator
Figure 8–17



Fuel Quantity Gage Tank Unit Installation
Figure 8–21

8.3.6 Free Air Temperature Indicator

The free air temperature indicating system is provided to indicate the free air temperature. This system includes a temperature sensing bulb and temperature indicator. On the R.H. side of the forward fuselage is located the sensing bulb made of nickel resistance wire which changes its resistance depending on the free air temperature, sending signals to the temperature indicator. The scale of the temperature indicator is graduated between -50°C and +50°C.

8.4 Gyro Instruments

8.4.1 Power Fail Warning System

The electric power supplied to the gyro instruments for the pilot and the copilot is 400 c/s, 115V, 3 phase current which is converted from single phase current by a phase adapter since the inverter output is single phase current. Thus, in order to warn the failure of power to the gyro instruments,a power failure light is provided on the instrument panel.

When this light is on, power is not fed to the gyros and when it is not, power is fed to the gyros.

8.4.2 Attitude Gyro Indicator

This instrument utilizes the gyro rigidity and its outer case moves relatively depending on the aircraft attitude so that the gyro shaft can be kept vertical all the time. The power supplied is 115V, 400 c/s, 3 phase with phase rotation of A-B-C and the gyro runs at 21,000 rpm.

Inside the indicator is located an "OFF Flag" which is actuated by a single phase, AC motor. On the front side of the instrument are provided a cage knob and an attitude knob. The sphere of the gyro can be set to the neutral position from any position by pulling out this cage knob.
Trim in pitch direction can be taken 5° upwards and 10° downwards by rotating the attitude knob.

8.4.3 Turn and Bank Indicator

In this instrument are installed the turn indicator and the bank indicator together, the former primarily consisting the rate gyro and the latter mainly consists primarily of the level.

When the aircraft makes a turn, its angular velocity is represented by the movement of the needle which covers a range up to 180°/min, 5/32."

The needle moves to the left for the left turn and to the right for the right turn.

During the level flight, the ball of the bank indicator rests in the direction of gravity, that is, at the center of the level, but when the aircraft is slipping sideways, the ball moves to the direction of the resultant force of gravity and centrifugal force. The motor operates on 115V, 400 c/s, 3 phase with the phase rotation of A-B-C at 22800 rpm.

8.5 Liquid Quantity Indicators

8.5.1 Fuel Quantity Indicator

The fuel quantity indication in the YS-11 is based on the principle of electric capacitance measurement. The tank unit is always submerged in fuel in the tank and compares its electric capacitance with a reference condenser, transmitting signals to the indicator, to keep the circuit in balance. Consequently, the scale of the indicator is graduated in weight.

In the fuel tank are installed three tank units connected in parallel and by the side of the innermost unit is located a compensator submerged in fuel all the time, making compensation for temperature change. If the temperature of fuel rises and its density decreases, the dielectric constant increases. As such variation results in erroneous indication, the compensator is provided to correct this error. An amplifier is provided between the tank unit and the indicator. This amplifier consists of a reference condenser, amplifier to amplify the follow up signals, indicator and variable resistor for adjustment of the zero point and the full point. By the indicator is provided a test switch which is used to break the balance of the fuel quantity indication to return the needle to zero.

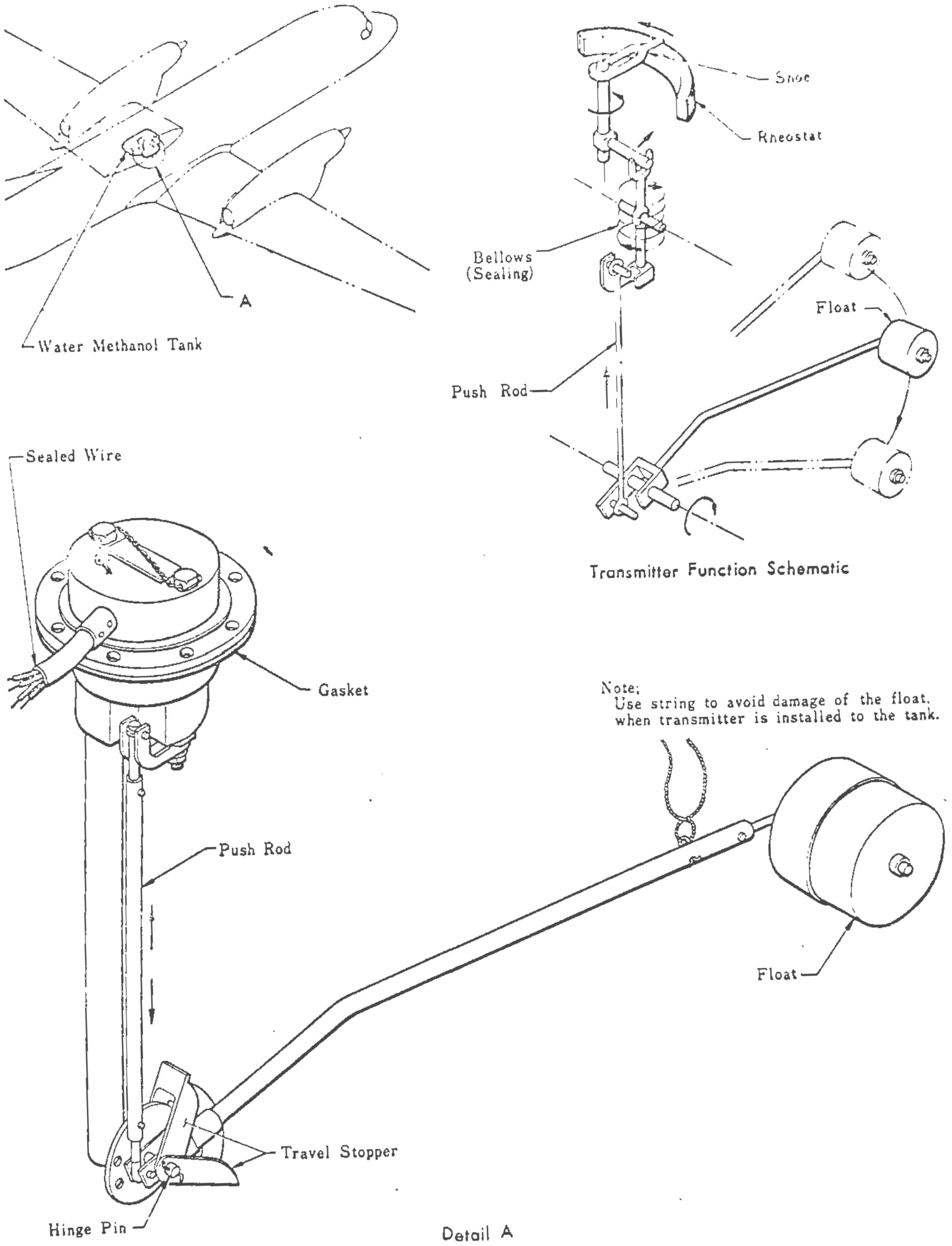
8.5.2 Hydraulic Oil Quantity Indicator

An indicating system of electric capacitance type is provided to indicate the oil quantity in the hydraulic reservoir. Its operating principle is the same as that of the fuel quantity indicating system, consisting of the tank unit, amplifier and indicator. However, no compensator is provided since the hydraulic oil is not sensitive to the temperature variation. The scale of the indicator is graduated in %.

8.5.3 Water Methanol Quantity Indicator

This indicator is provided to indicate the water methanol quantity. This system consists of a signal generator in the methanol bag tank and an indicator located on the main instrument panel. This system is of DC selsyn type and its scale is graduated in U.S. Gal. The signal generator, utilizing a float to change electric resistance, transmits the signals to the indicator. The instrument has the following marking:

Red radial	30 U.S.G.
Yellow'arc	30 to 38 U.S.G.
Green arc	38 to F U.S.G.

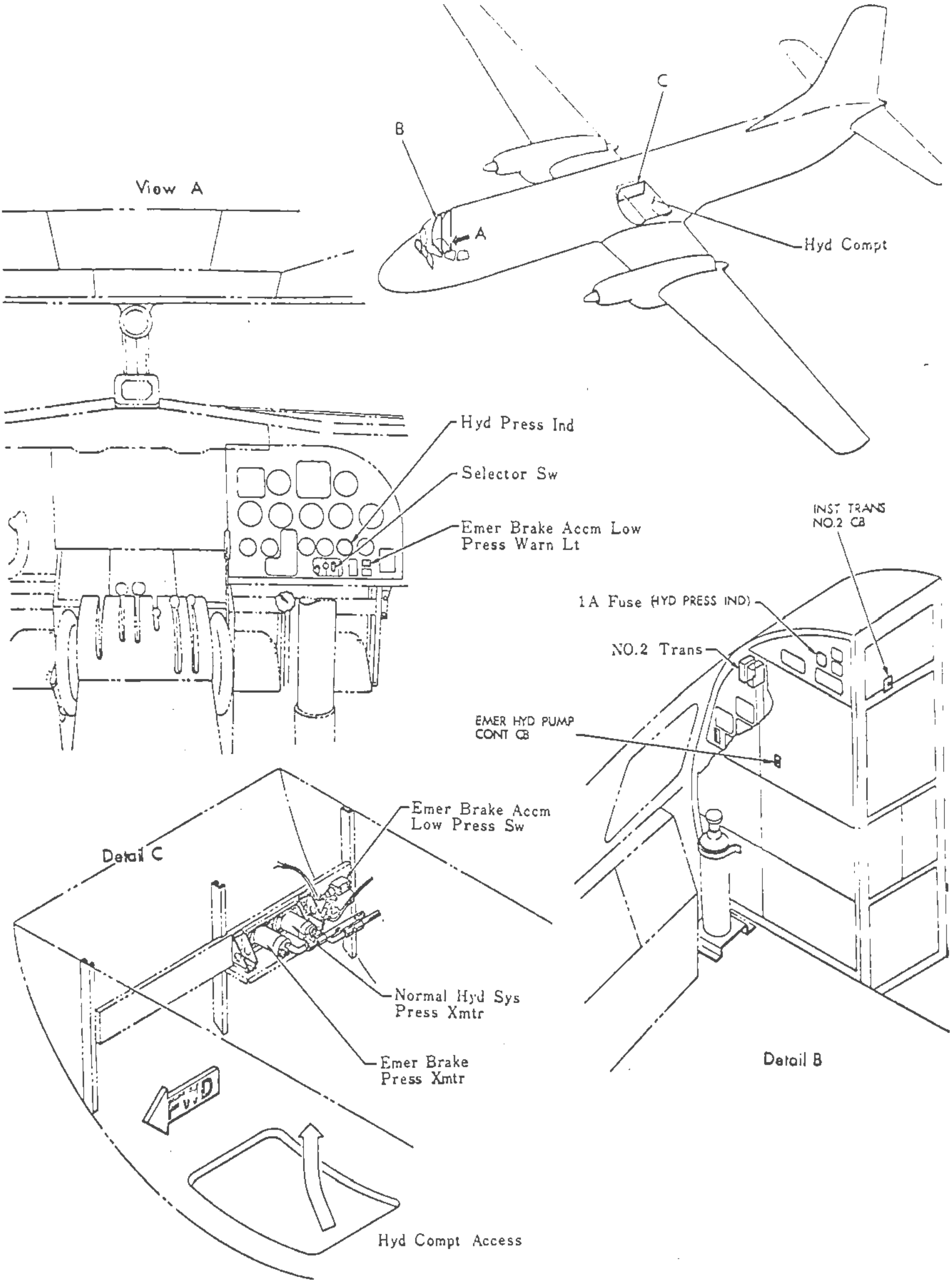


Transmitter Function Schematic

Note;
Use string to avoid damage of the float, when transmitter is installed to the tank.

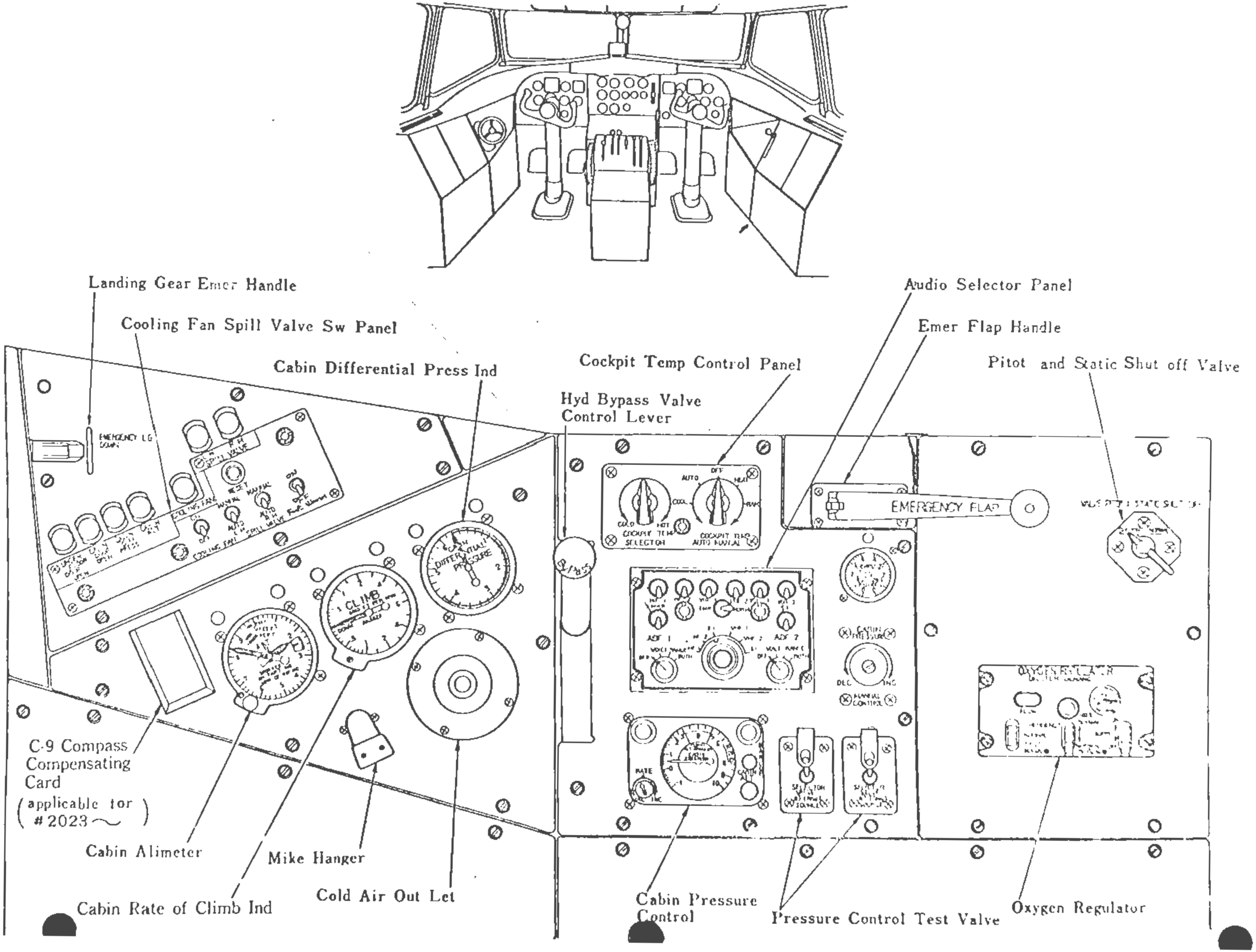
Detail A

W/M Quantity Transmitter
Figure 8–23

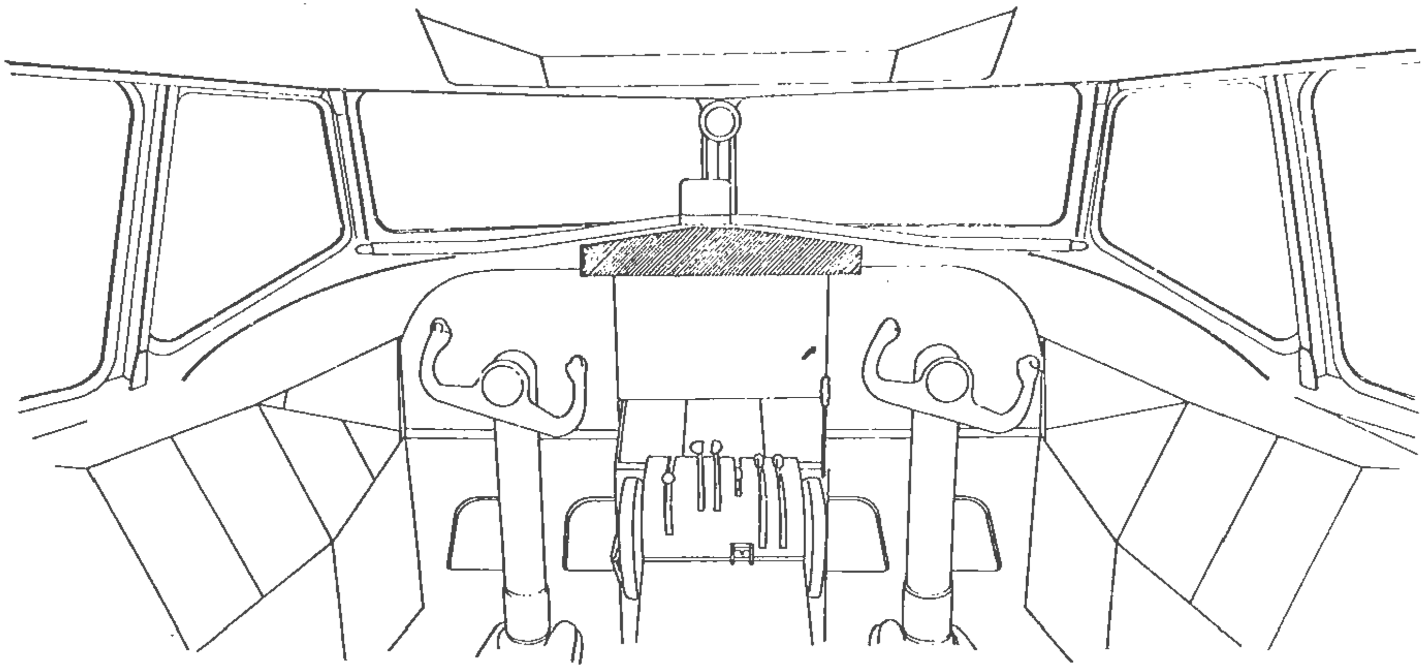


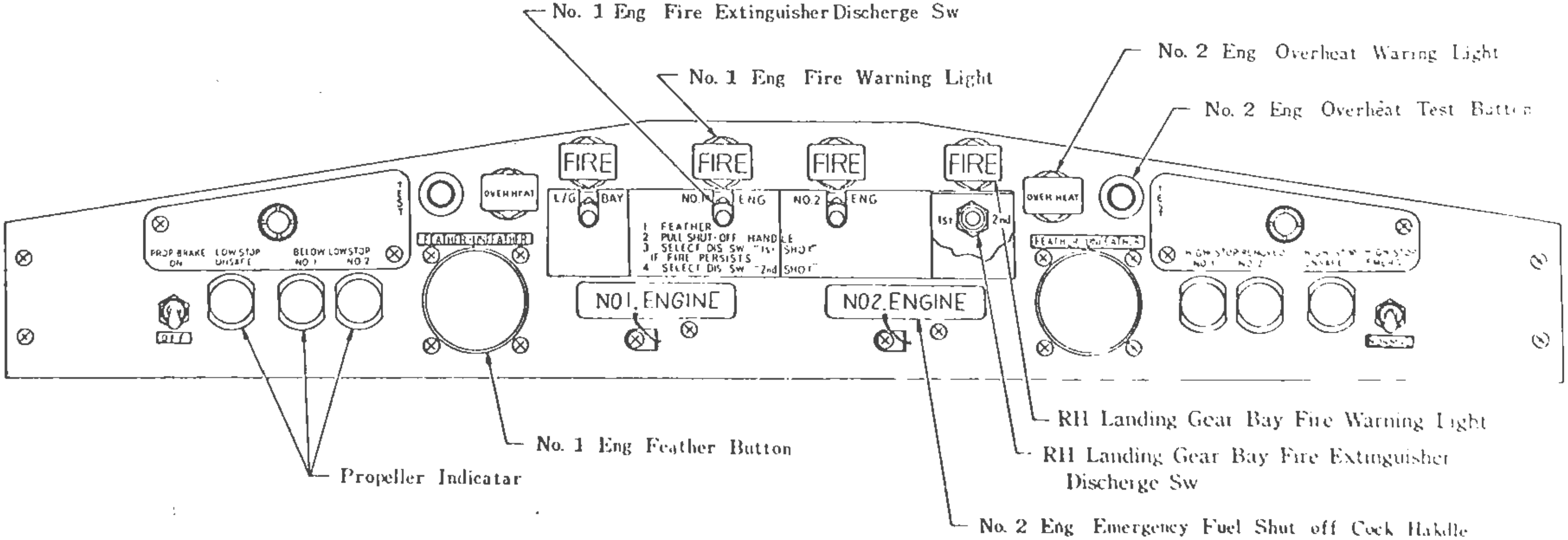
Hydraulic Pressure Indicating and Warning System

Figure 8–25

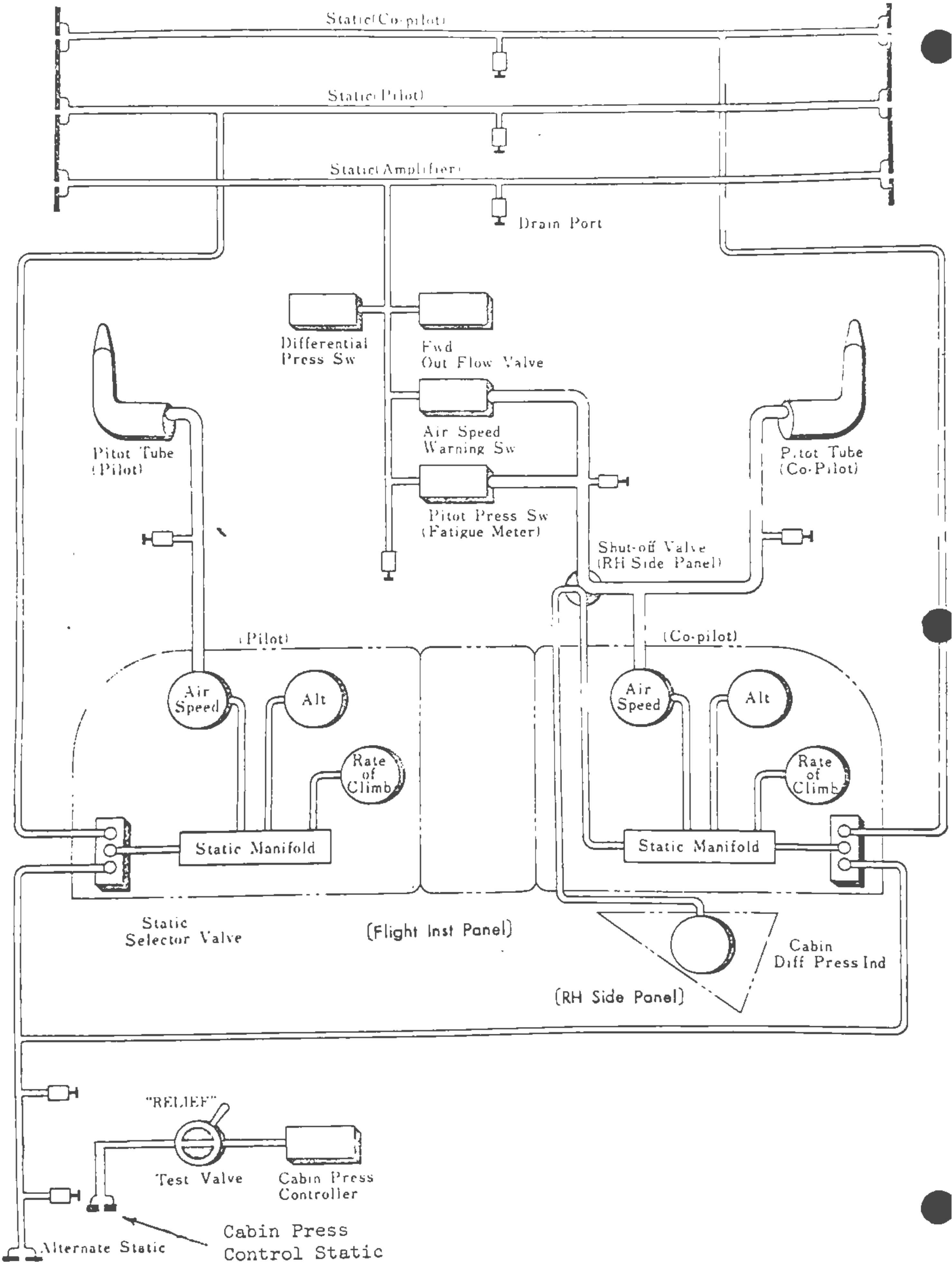


RH Side Panel
Figure 8-6

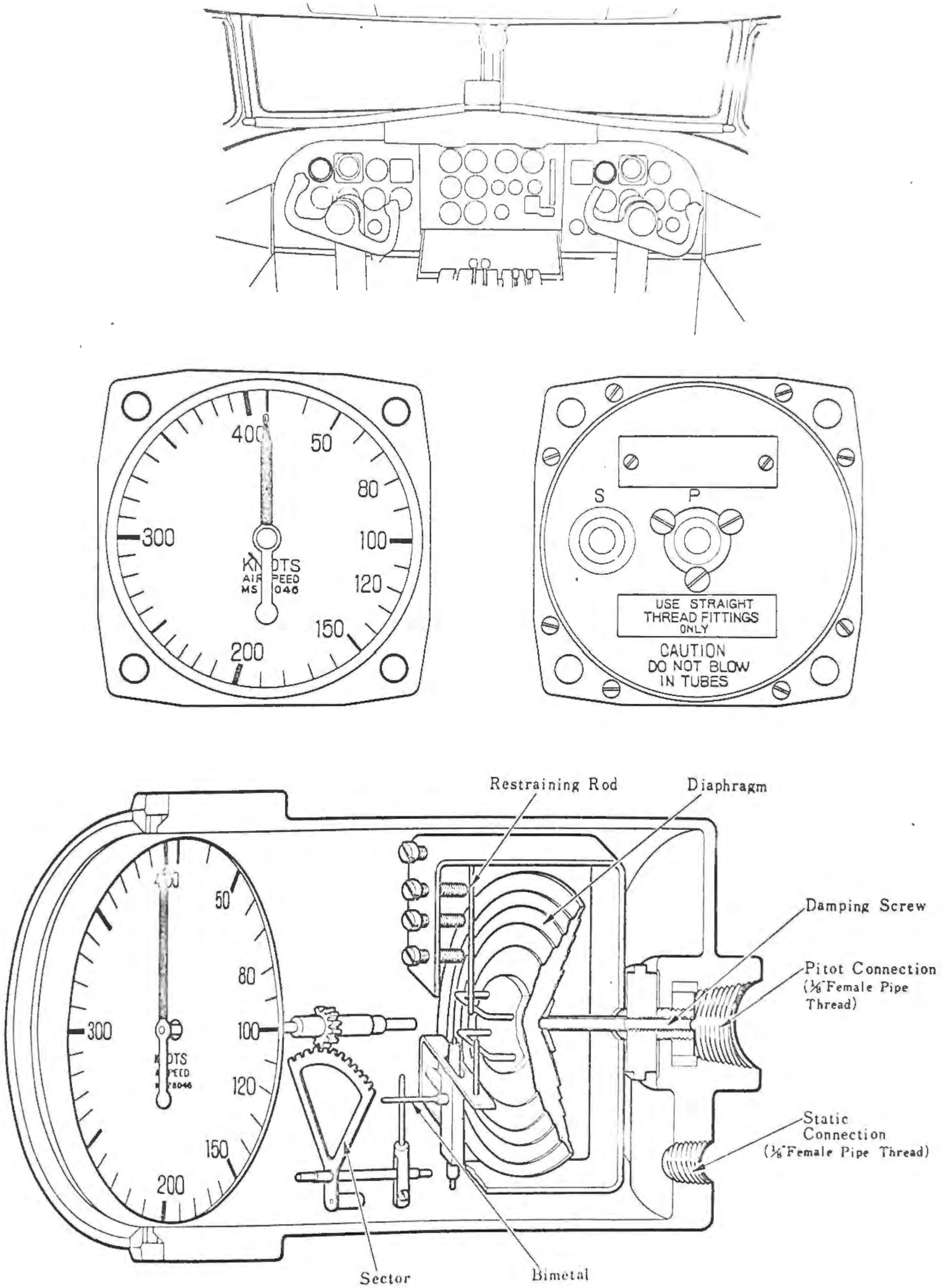



No. 1 Eng Fire Extinguisher Discherge Sw
No. 1 Eng Fire Warning Light
No. 2 Eng Overheat Waring Light
No. 2 Eng Overheat Test Batton
TEST
PROP BRAKE ON
LOW STOP UNSAFE
BELOW LOWSTOP NO 1
NO 2
OFF
OVER HEAT
FEATHER INDICATOR
FIRE
FIRE
FIRE
FIRE
L/G BAY
NO.1 ENG
NO.2 ENG
1 FEATHER
2 PULL SHUT-OFF HANDLE
3 SELECT DIS SW "1st SHOT"
IF FIRE PERSISTS
4 SELECT DIS SW "2nd SHOT"
1st
2nd
NO1.ENGINE
NO2.ENGINE
OVER HEAT
FEATHER INDICATOR
TEST
RH Landing Gear Bay Fire Warning Light
RH Landing Gear Bay Fire Extinguisher Discherge Sw
No. 1 Eng Feather Button
Propeller Indicatar
No. 2 Eng Emergency Fuel Shut off Cock Hakdle

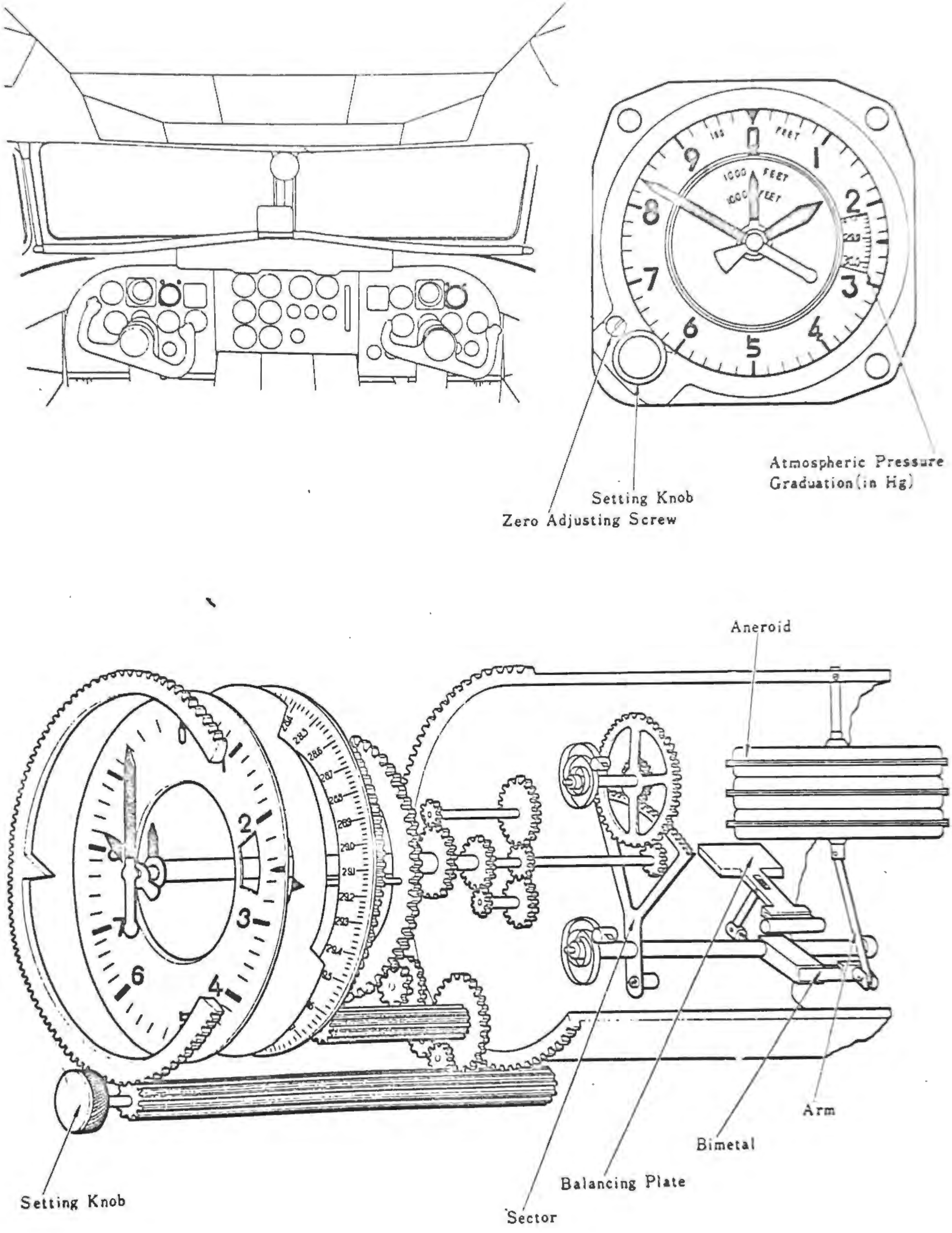
Auxiliary Panel
Figure 8-7



Pitot Static System Schematic Diagram
Figure 8-8



Airspeed Indicator
Figure 8–11



Altimeter
Figure 8–13

8.3.2 Airspeed Indicator

The airspeed indicators are installed 1 ea. on the panels for the pilot and the copilot, indicating the airspeed of the aircraft. The indication is given in knots, ranging from 0 to 400 Kt. On the back side of the instrument are provided "P" and "S" connections which are connected to the Pitot and the static tubes, respectively.

8.3.3 Speed Warning System

A buzzer goes off and lights come on when the airspeed reaches V_{mo} + 6 Kt, to inform the pilot of V_{mo} at a given altitude.

V_{mo} at various altitudes is given below:

0 to 13000 ft	245 Kt
16000 ft	231 Kt
19000 ft	218 Kt
22000 ft	204 Kt

The buzzer is located on the L.H. side panel and the lights are installed above the airspeed indicators for the pilot and the copilot. Above the airspeed indicator for the copilot is provided a button which is used to check the speed warning system of the aircraft.

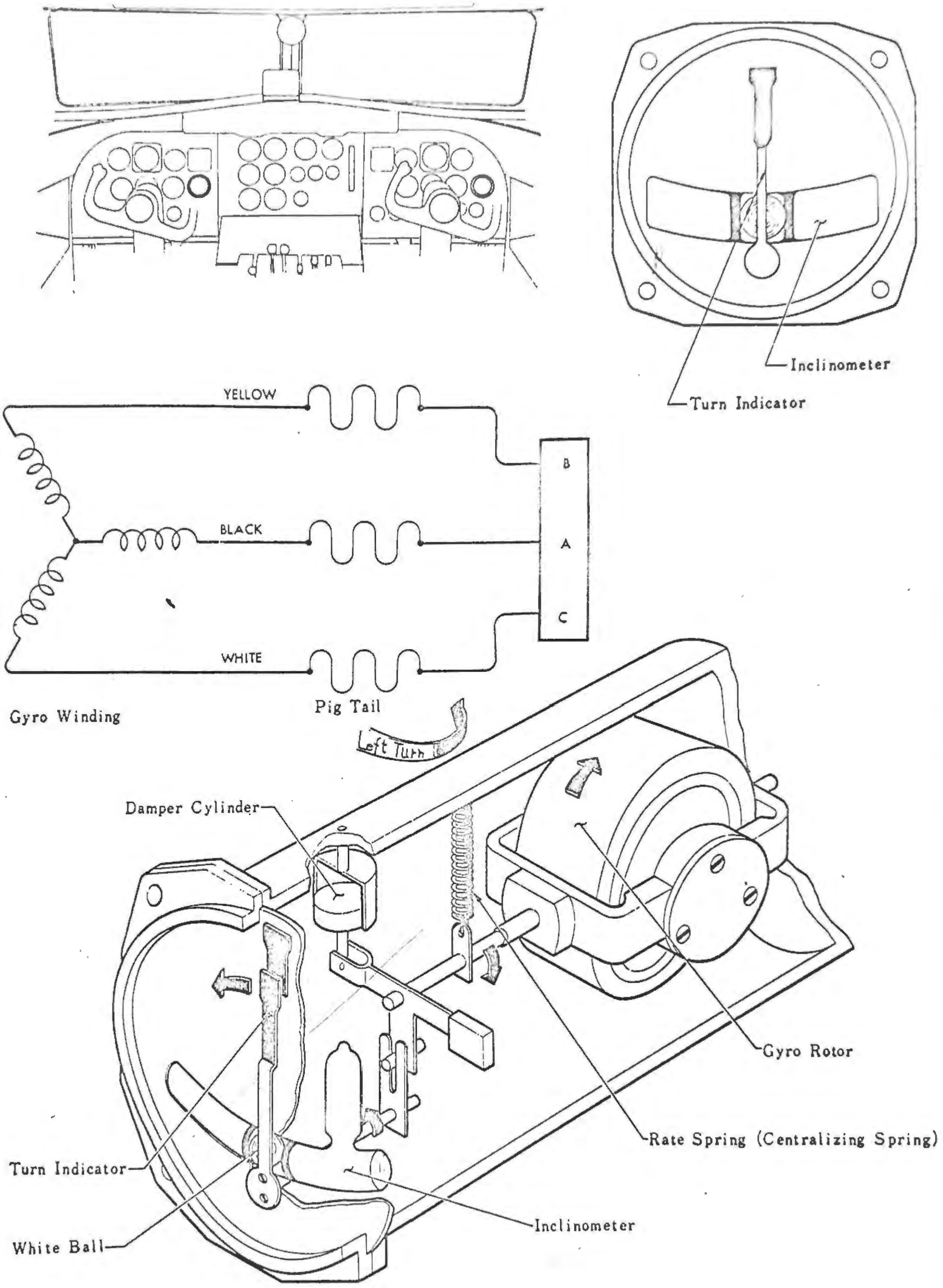
8.3.4 Altimeter

The altimeters are provided 1 ea. for the pilot and the copilot, indicating pressure altitude of the aircraft. The indication is given in feet with a long needle of 100 foot index, 1 turn corresponding to 1000 ft, an medium needle of 1000 foot index, turn corresponding to 10000 feet and a short needle of 10000 foot index.

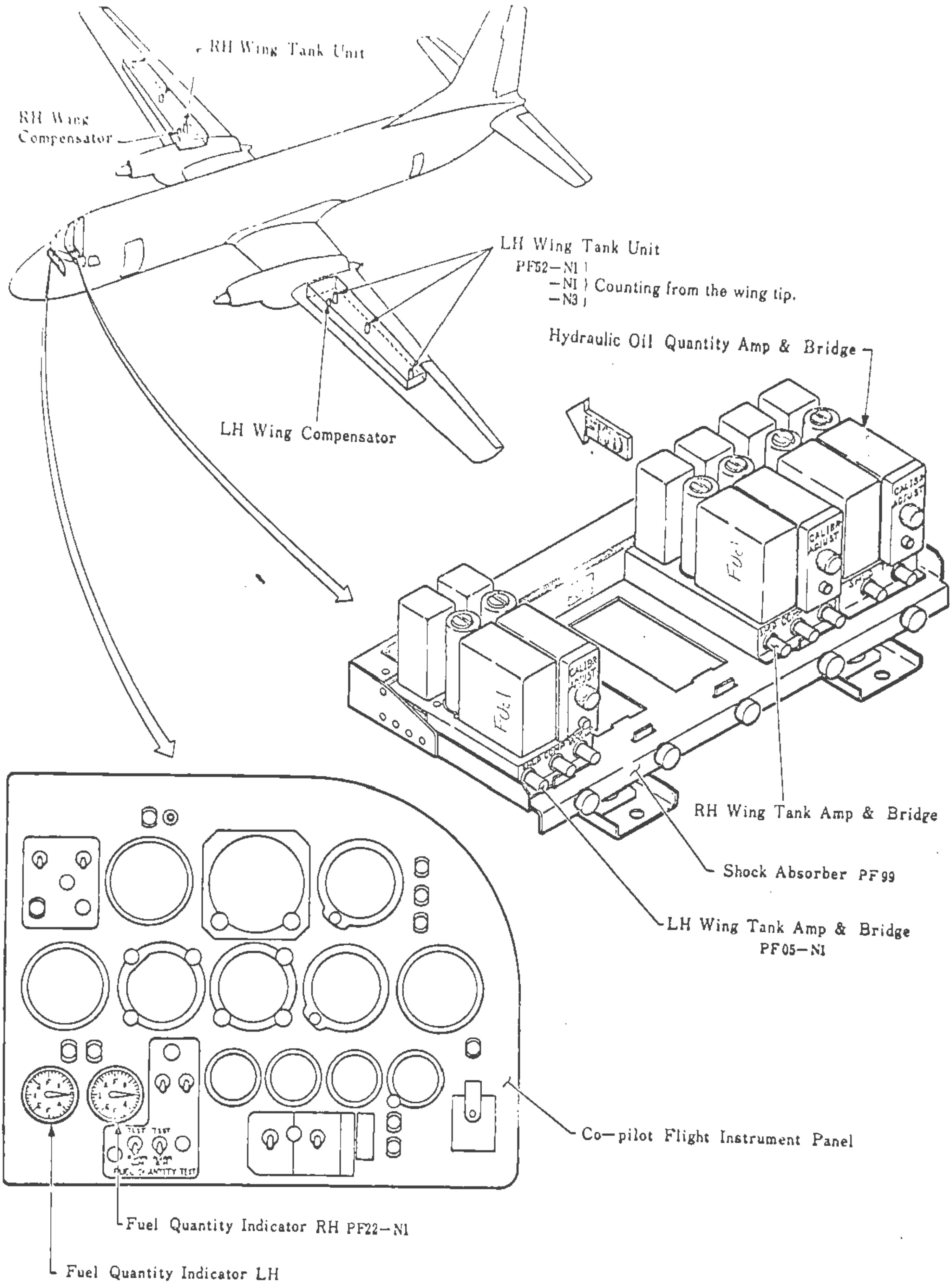
In front of each instrument is provided a barometric pressure setting knob which permits to set the barometric scale (28.1" to 31.0") to any desired pressure. On the back side of the instrument is provided a static connection.

8.3.5 Rate of Climb Indicator

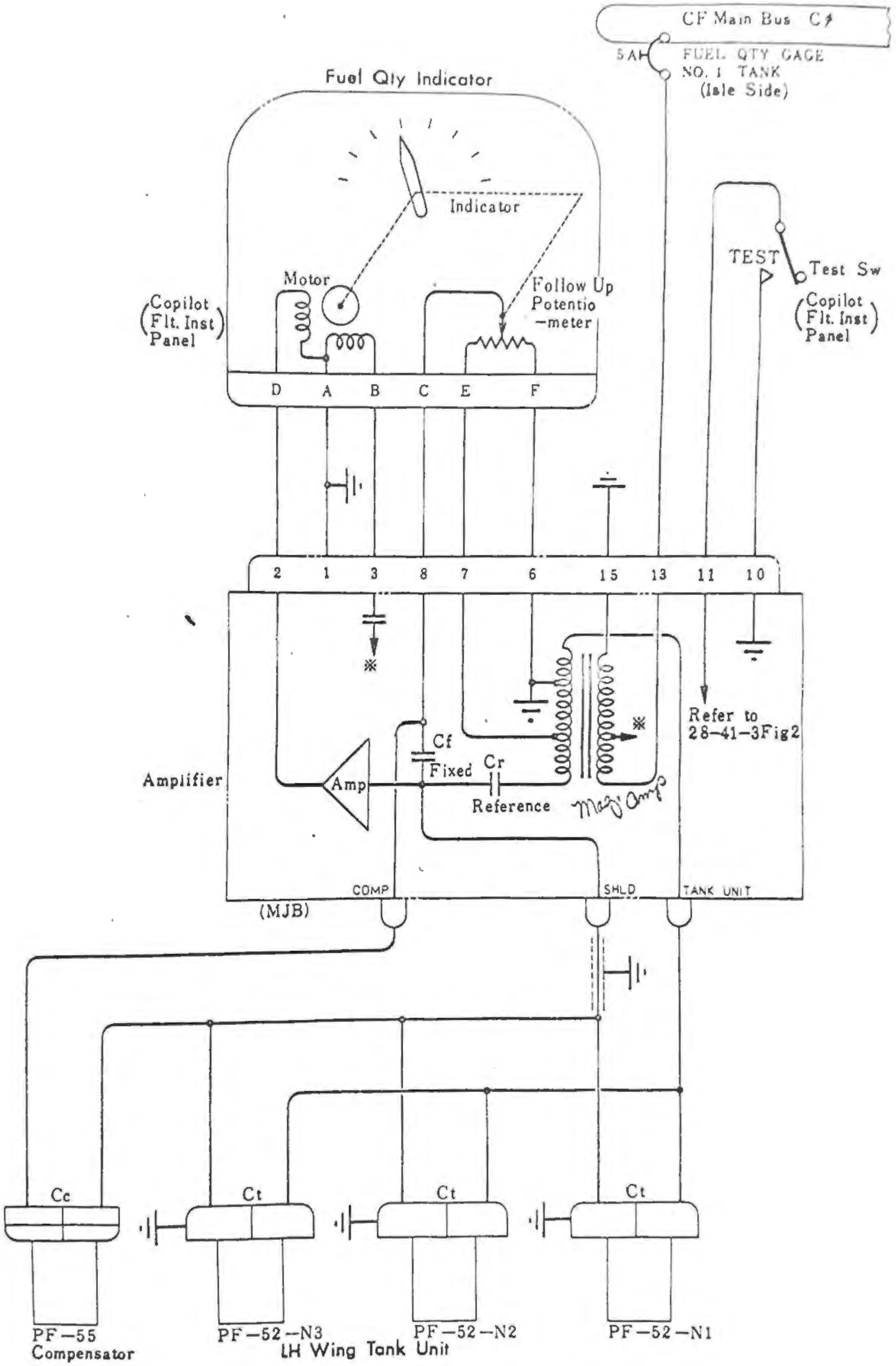
The rate of climb indicators are installed 1 ea. on the instrument panels for the pilot and the copilot, indicating rate of climb or descent of the aircraft per minute. This instrument is divided into two zones - the upper zone for climb and the lower zone for descent, with logarithmic scale graduated from 0 to 6000 ft/min. On the back side of the instrument is provided a static pressure connection.



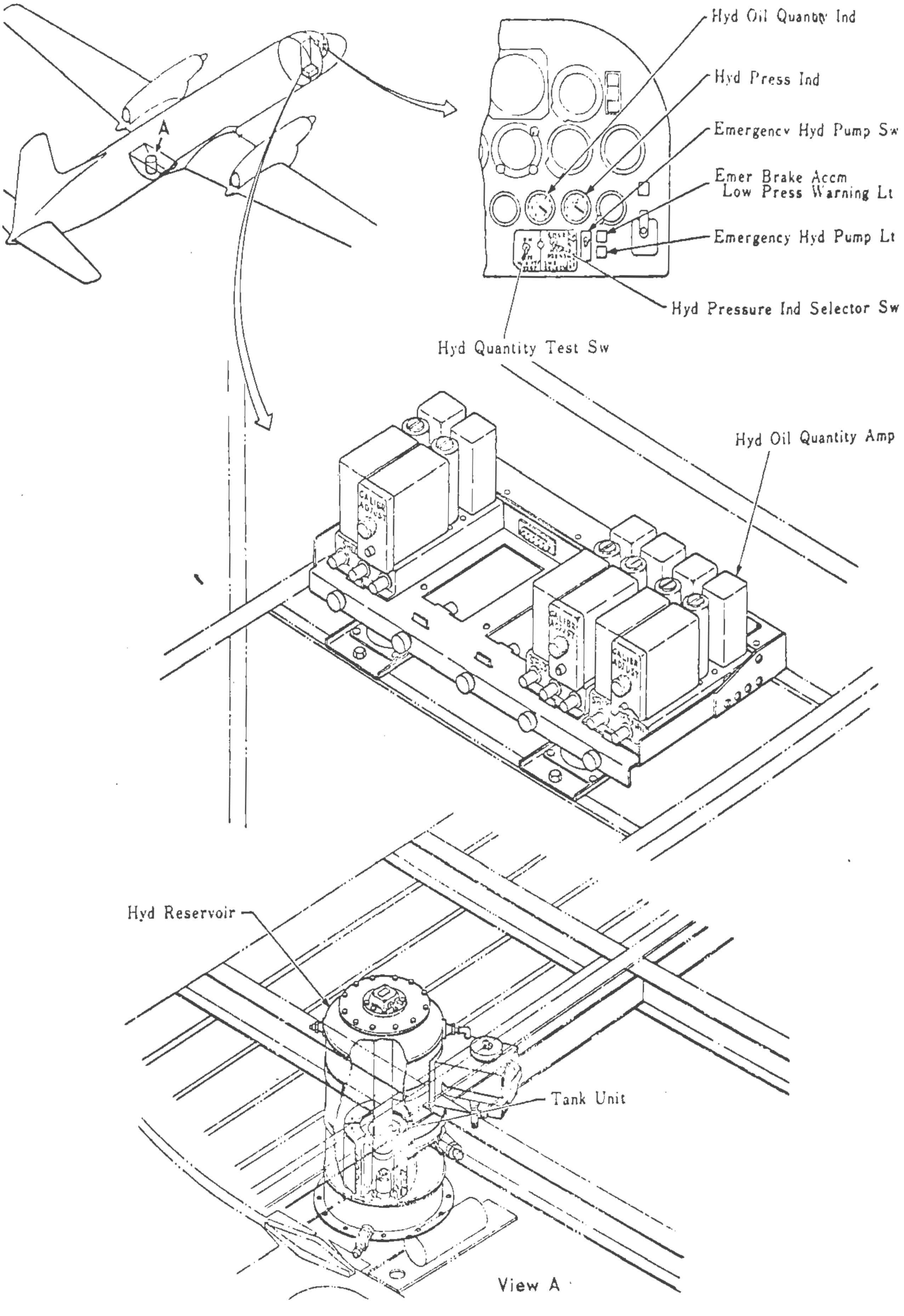
Turn & Slip Indicator
Figure 8–18


RH Wing Tank Unit
RH Wing Compensator
LH Wing Tank Unit
PF52—N1
—N1 } Counting from the wing tip.
—N3
Hydraulic Oil Quantity Amp & Bridge
FWD
LH Wing Compensator
CALIBR ADJUST
Fuel
RH Wing Tank Amp & Bridge
Shock Absorber PF99
LH Wing Tank Amp & Bridge
PF05—N1
Co—pilot Flight Instrument Panel
FUEL QUANTITY TEST
Fuel Quantity Indicator RH PF22—N1
Fuel Quantity Indicator LH

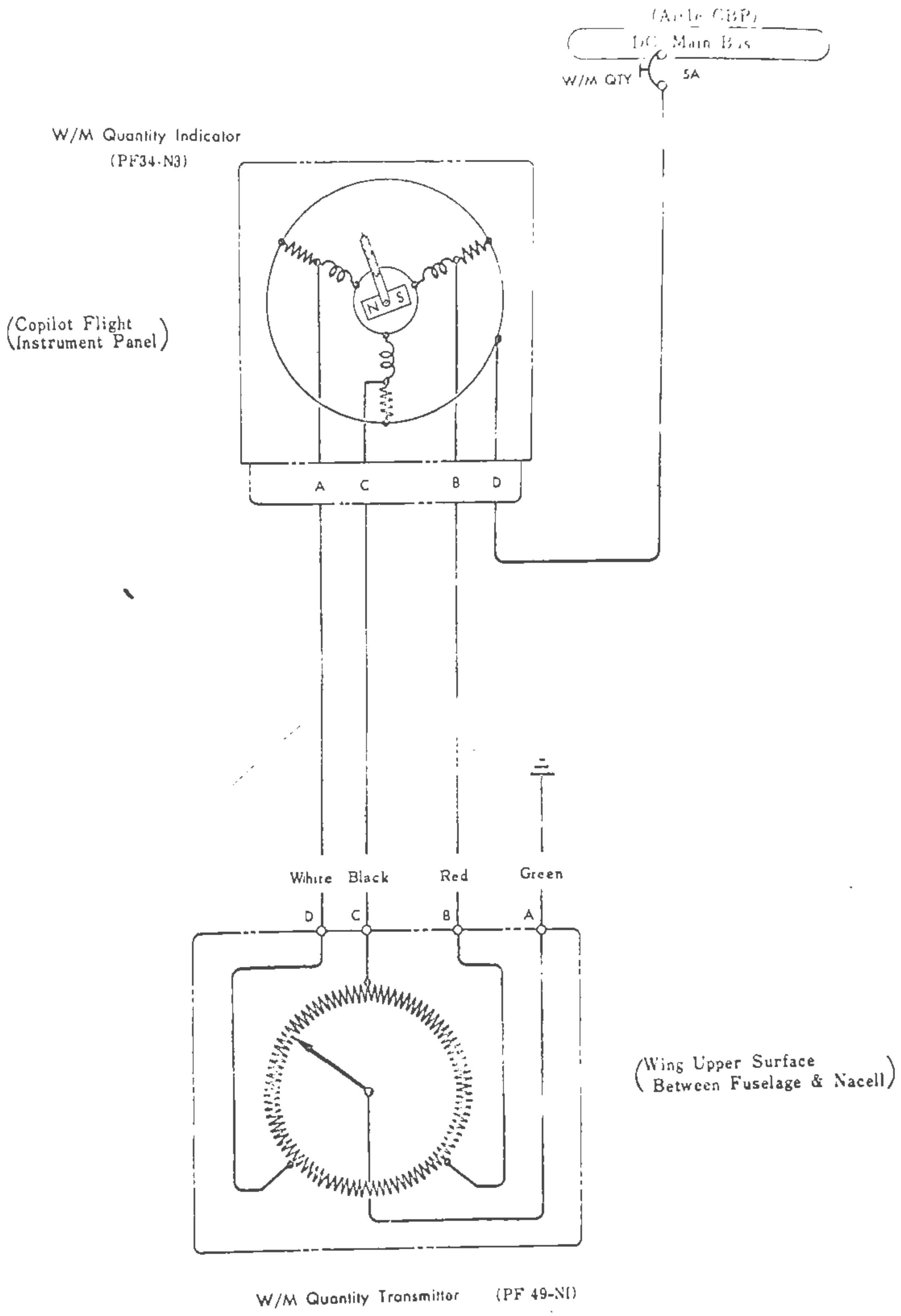
Fuel Quantity Indicating System Component Location
Figure 8—19



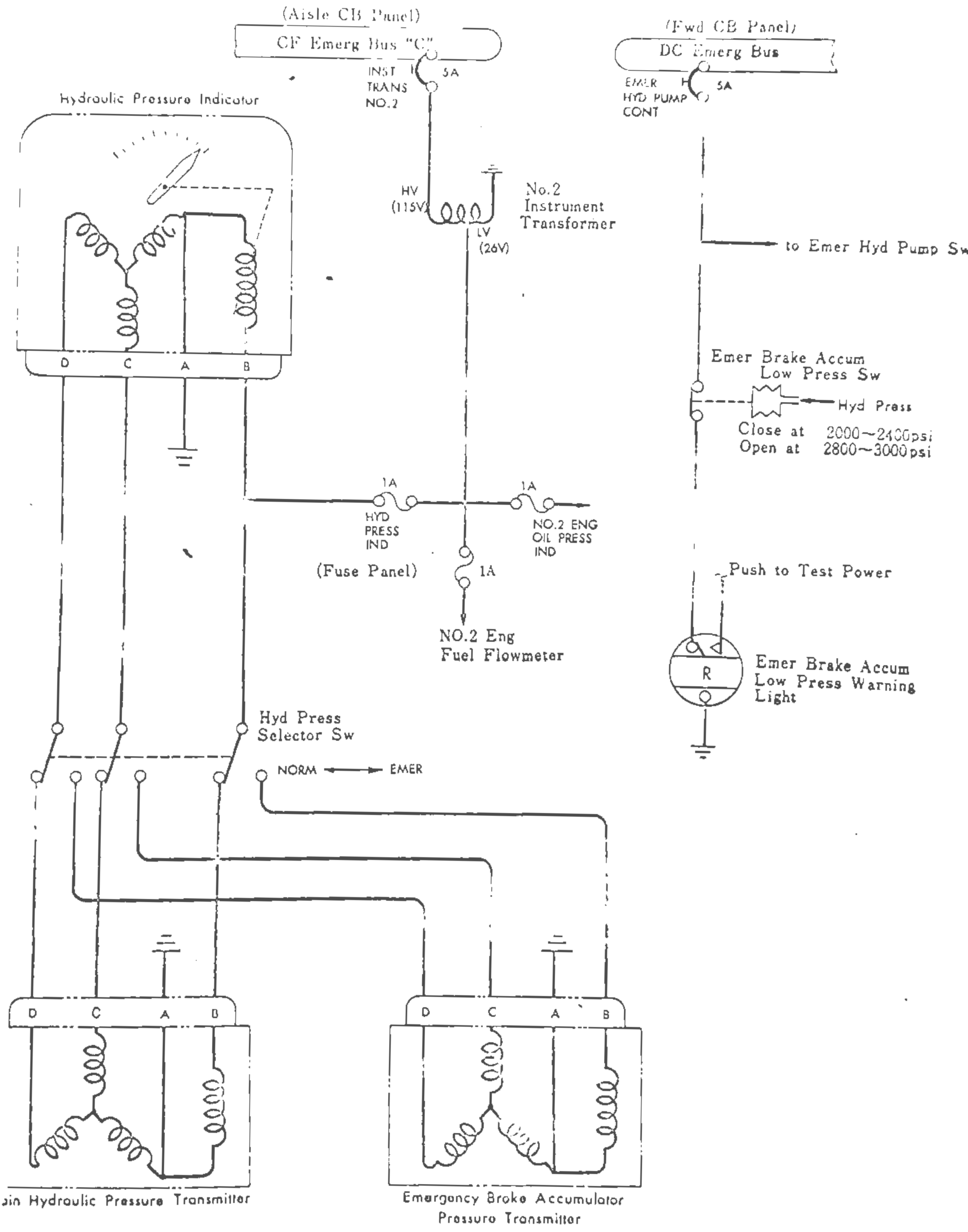
Fuel Quantity Indicating System Schematic
Figure 8-20 .



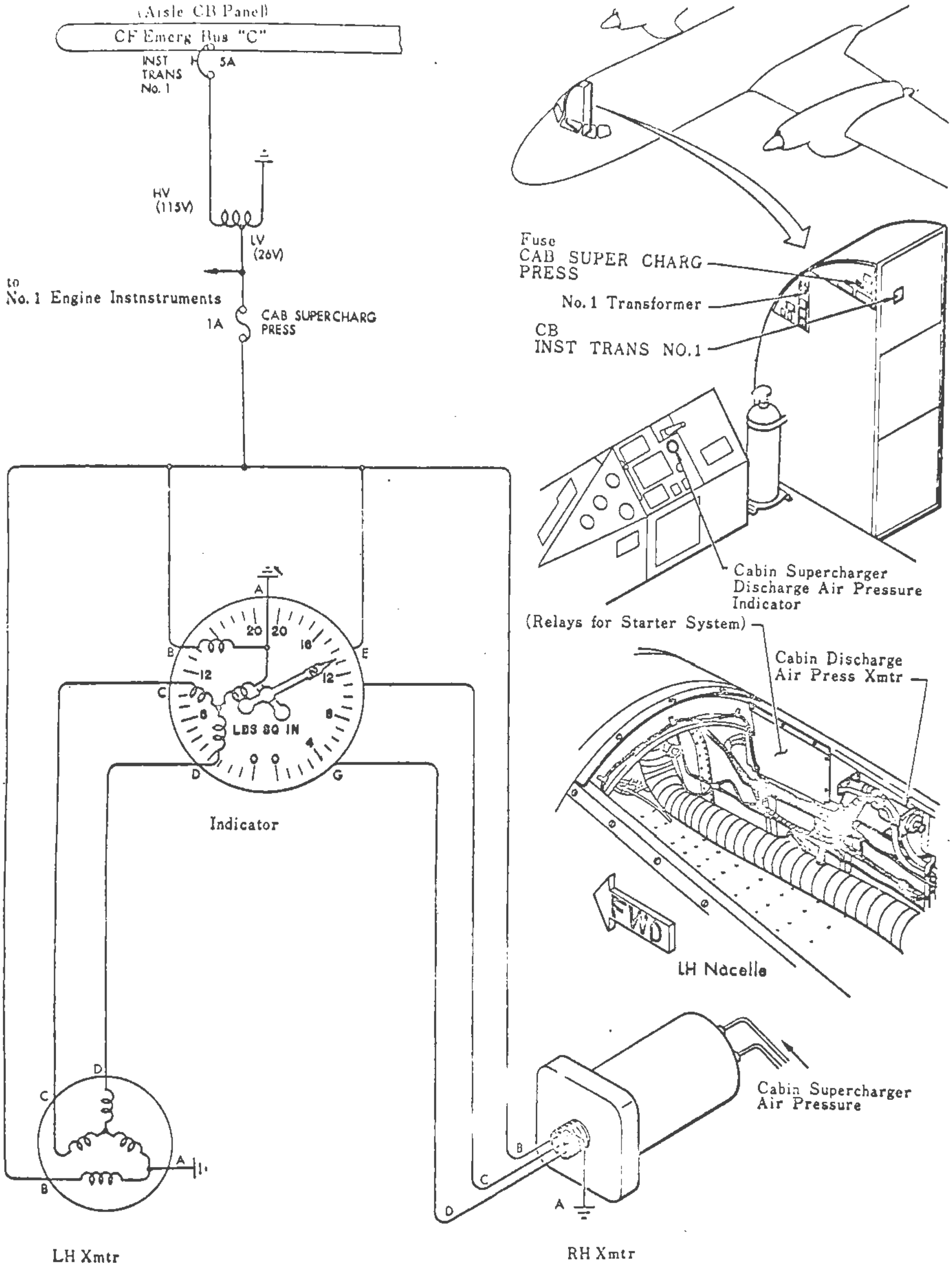
Hydro Oil Quantity Indicating System
Figure 8-22



W/M Quantity Indicating System Schematic
Figure 8–24



Hydraulic Pressure Indicating and Warning
Figure 8–26



Cabin Supercharger Discharge Air Pressure Indicating System

Figure 8–27

8.6 Pressure Instruments

8.6.1 Hydraulic Pressure Indicator

The hydraulic pressure indicating system is provided to indicate the hydraulic pressure.

In the main hydraulic system line and the emergency hydraulic line are located the signal generators which convert the hydraulic pressure into electric signals and send them to the instrument. There is provided only one instrument which can be switched to EMERGENCY or NORMAL by the selector switch. This system is an auto-synchro operating on AC 26V.

The scale of the instrument is graduated from 0 to 4000 psi and it is provided with the following marking:

Red radial	2500 psi
Green arc	2500 to 3300 psi
Yellow arc	3300 to 3500 psi
Red radial	3500 psi

8.6.2 Cabin Supercharger Discharge Pressure Indicator

This indicator is an AC synchro instrument, consisting of a signal generator and an instrument, and indicates the delivery pressure of the cabin supercharger. The signal generator converts the pressure difference between the outlet and the inlet of the cabin supercharger into electric signals which are transmitted, in turn, to the instrument located on the R.H. side panel. This indicator has two needles, No. 1 for the L.H. supercharger and No. 2 for the R.H. supercharger. The scale is graduated between 0 and 22 lb/in^2.

8.7 Deleted

8.7.1 Deleted

8.8 Engine Instruments

8.8.1 Torque Pressure Indicator

When the engine shaft horse power is transmitted to the propeller, thrust in the axial direction represents the torque. This is converted by the signal generator into electric signals which are transmitted to the instrument in the cockpit. The indicator is graduated between 0 and 500 psi and provided with the following marking:

Yellow arc	0 to 40 psi

8.8.2 Engine Speed Indicator

On the gear box of the engine is mounted a tachometer generator which transmits signals to the indicator in the cockpit.

The tachometer generator generates a voltage with frequency in proportion to the engine speed in 3 phase Y connection and sends it to 3 phase winding of the indicator. Thus, the rotor in the indicator is moved and the needle, in turn, moves.

The indicator has two needles, long one for 100 rpm index and short one for 1000 rpm index. It is also provided with the following marking:

Green arc	8000 to 15000 rpm
Red radial	15050 rpm

8.8.3 Turbine Gas Temperature Indicator

12 thermo couples in 6 sets of 2 are installed in parallel on the intermediate turbine nozzle guide vanes to measure the temperature of the gas flow. The thermal electro-motive force generated in them is transmitted to an instrument in the cockpit. The instrument is a millivoltmeter with a scale from 0° to 1000°C.

The indication of this instrument is restricted by 25 ohm external resistance and is set at 780°C. The indicator is provided with the following marking:

Green arc	550°C to 820°C
Yellow arc	820°C to 865°C
Red arc	865°C to 890°C
Red radial	890°C

8.8.4 Fuel Flow Meter

This system operates on AC 26V, synchro, consisting of a transmitter and an indicator which are located in the landing gear nacelle and in the cockpit, respectively. The transmitter consists of a rotor with rotating vanes driven by fuel flow and a synchro with a magnet coupling. The synchro converts the fuel flow into electric signals which are transmitted to the indicator. The scale of the indicator is graduated between 0 and 2000 lb/hr.

8.8.5 Fuel Trim Indicator

When the fuel trim actuator is moved, the amount of trimming is indicated on an instrument. That is to say, the signals generated by the rotor of the transmitter moved by the lever mounted on the tip of the trim actuator are sent to an indicator located in the cockpit. This indicator has two zones; the left one for the L.H. engine and the right one for the R.H. engine. The scale is graduated in %.

8.8.6 Oil Temperature Indicator

A bulb and an indicator are provided to measure and indicate the temperature of oil. The bulb is located at the inlet of the oil pump of each engine. Its resistance changes depending on the temperature of oil so that the oil temperature can be indicated on the indicator. The scale of the instrument is graduated between -50°C and +150°C. The instrument is provided with the following marking:

Red radial	-30°C
Yellow arc	-30°C to -15°C
Green arc	-15°C to +120°C
Red radial	+120°C

8.8.7 Oil Pressure Indicator

This indicating system measures and indicates the oil pressure. Its transmitter is mounted on the right hand side of each engine compressor case. The scale of the instrument is graduated between 0 and 40 psi. It is an auto-synchro operating on AC 26V. The instrument is provided with the following marking:

Red arc	0 to 9 psi
Yellow arc	9 to 14 psi
Green arc	14 to 30 psi

8.9 Navigation Instruments

See Chapter 10, ELECTRONIC SYSTEM.

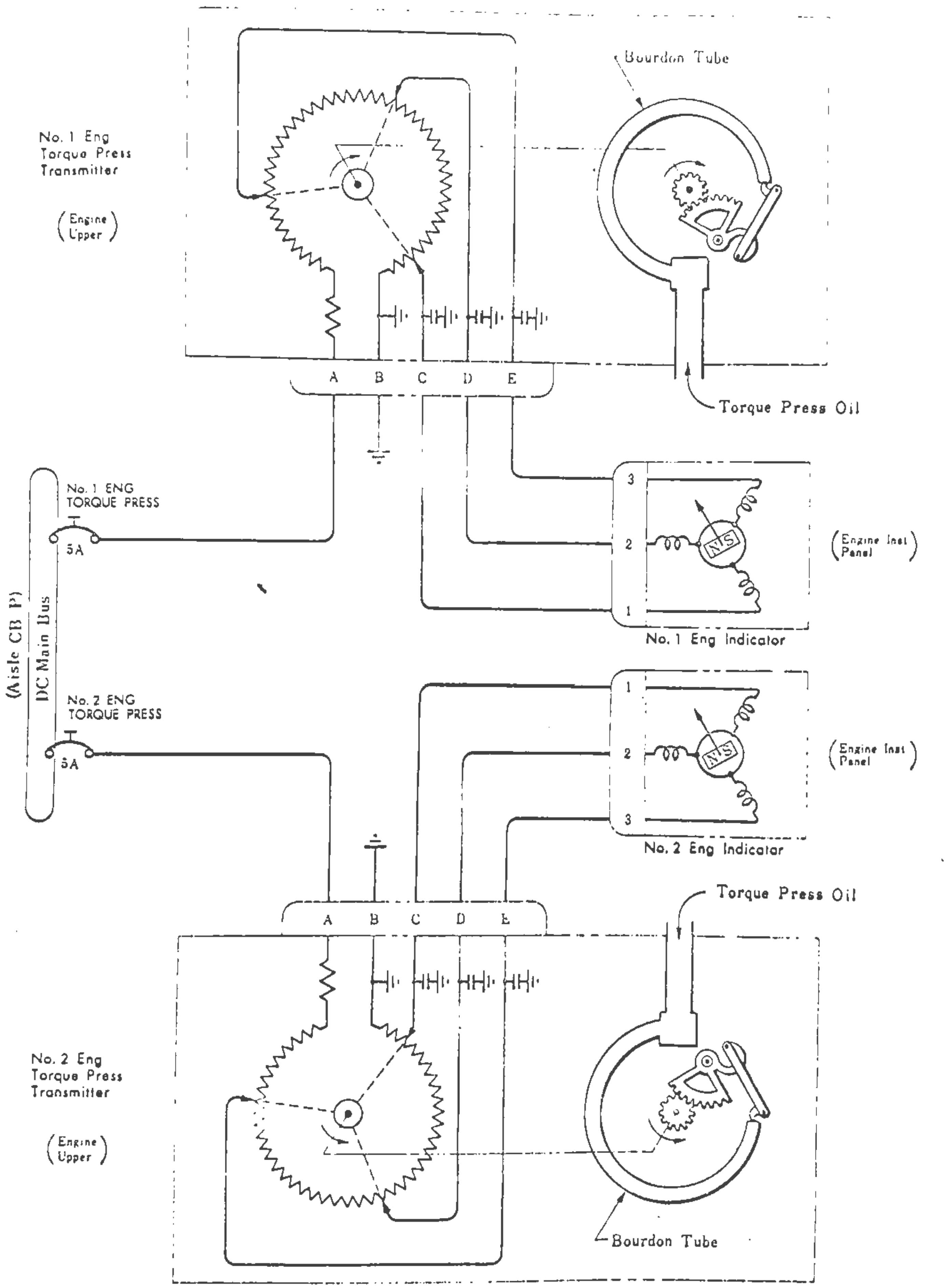
8.10 Miscellaneous Instruments

8.10.1 Clock

8 day clocks are mounted 1 ea. on the instrument panels for the pilot and the copilot.

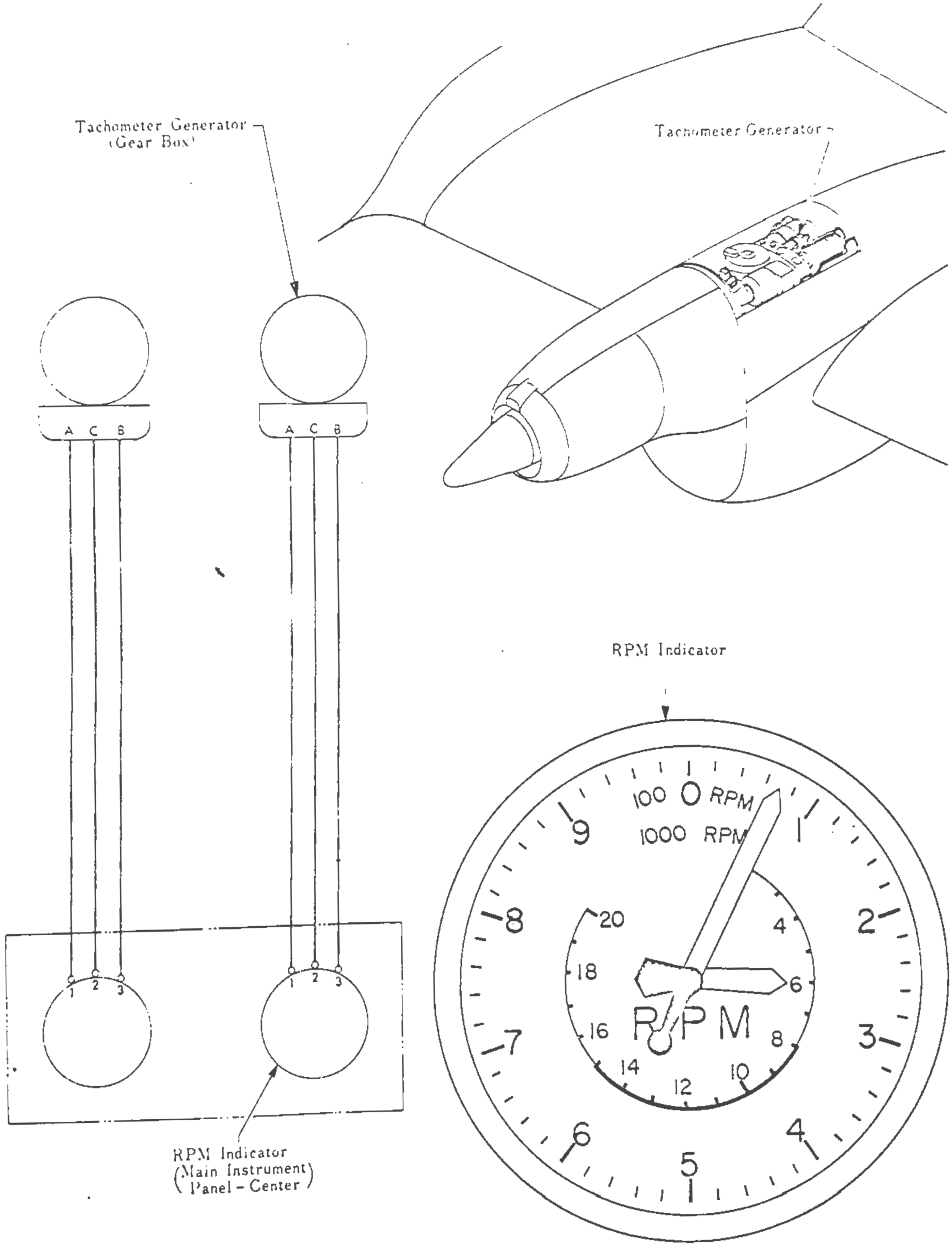
8.10.2 Flap Position Indicator

A flap position indicator is provided to indicate the flap angle. This system is of desyn type operating on 28V DC, and the transmitter is mounted on the flap gear box through a bevel gear. As the flap gear box rotates, signals are sent to the indicator. The scale is graduated between 0° and 35°.



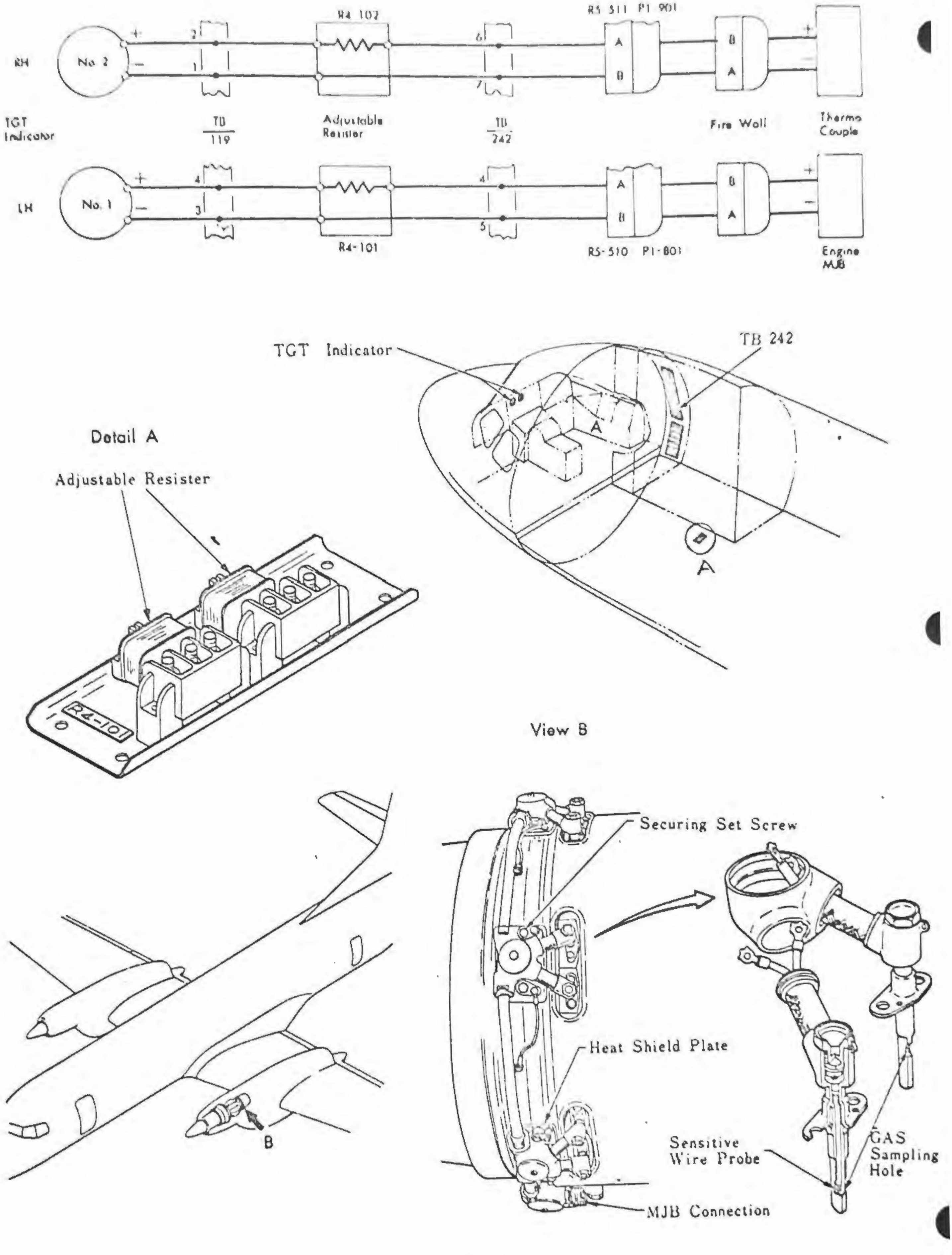
Torque Pressure Indicating System Schematic

Figure 8–28



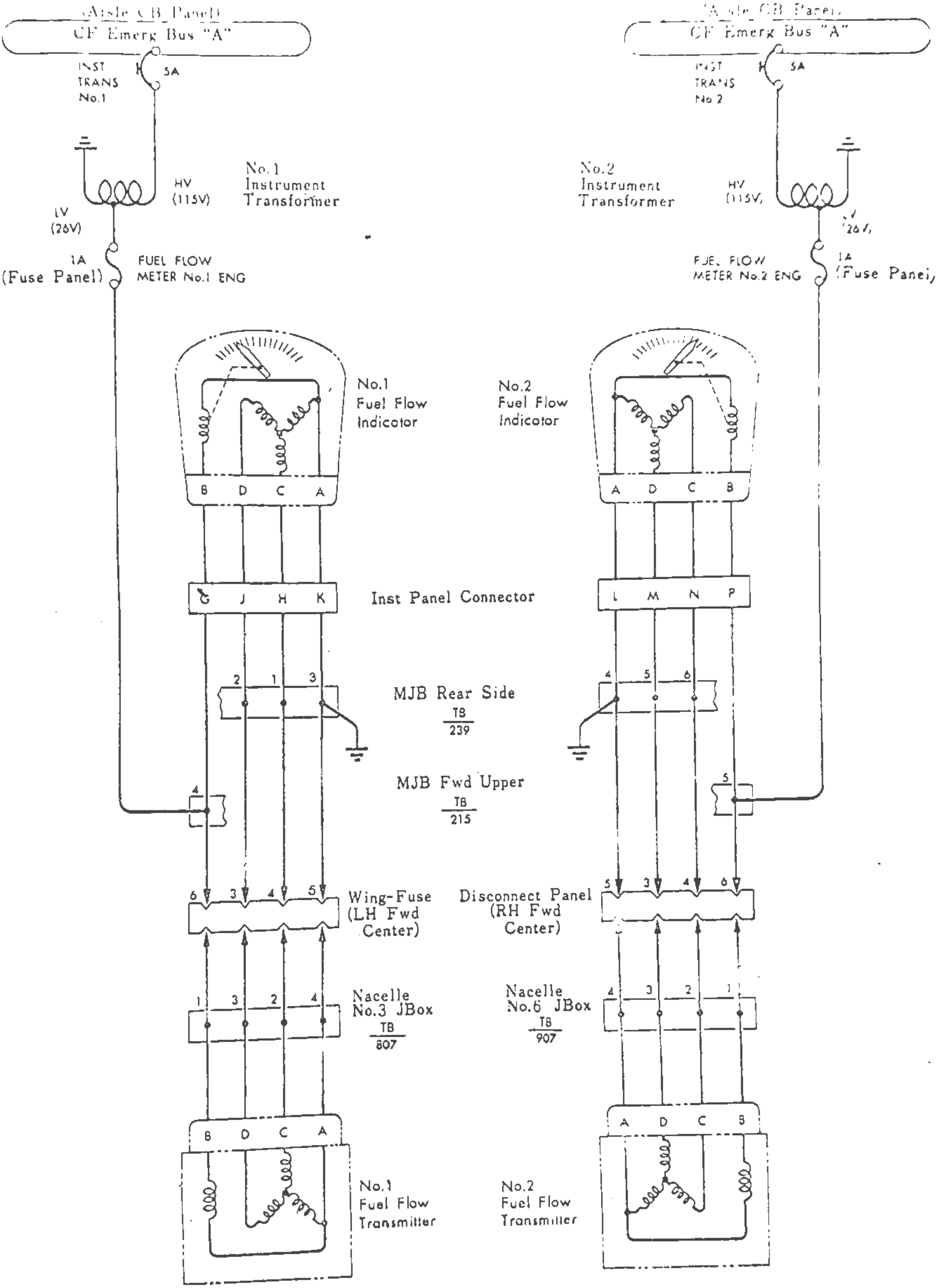
Engine Speed Theoretical Diagram

Figure 8–29



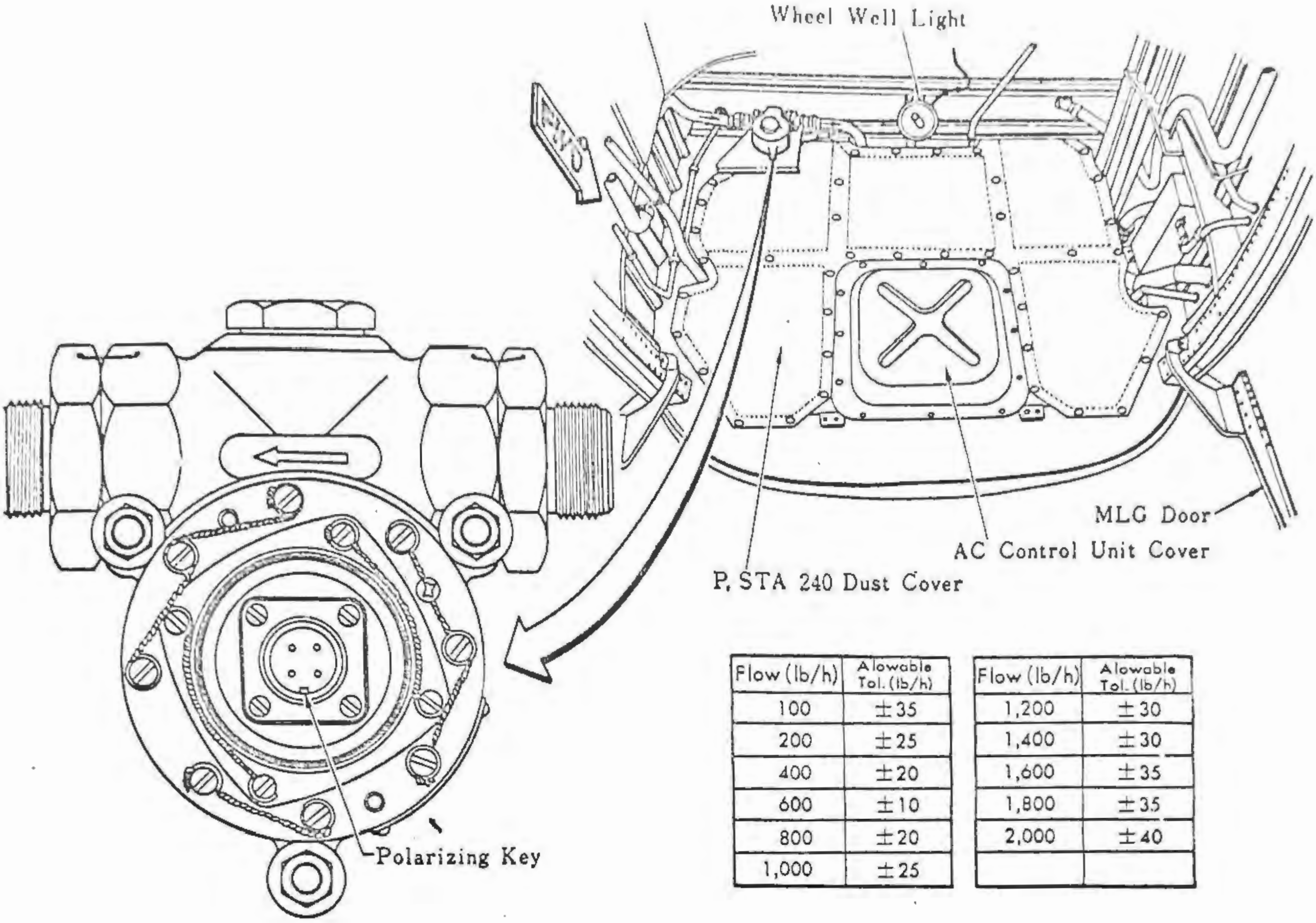
T. G. T. System

Figure 8–30

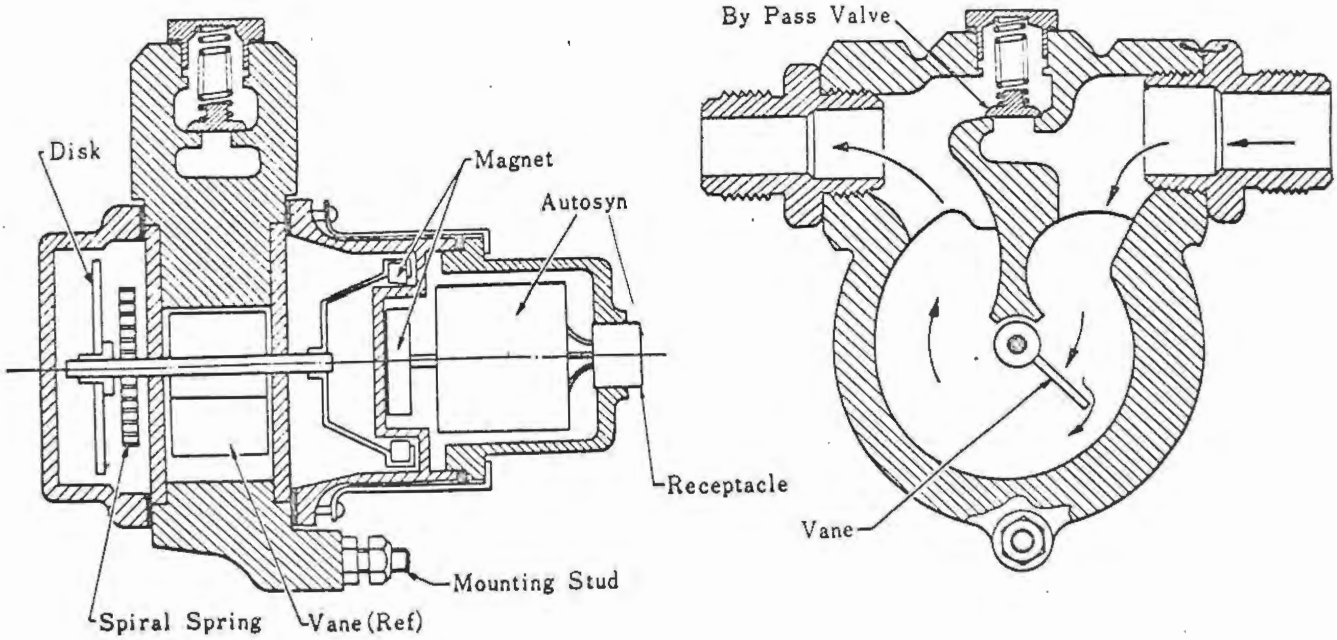


Fuel Flowmeter Wiring Schematic

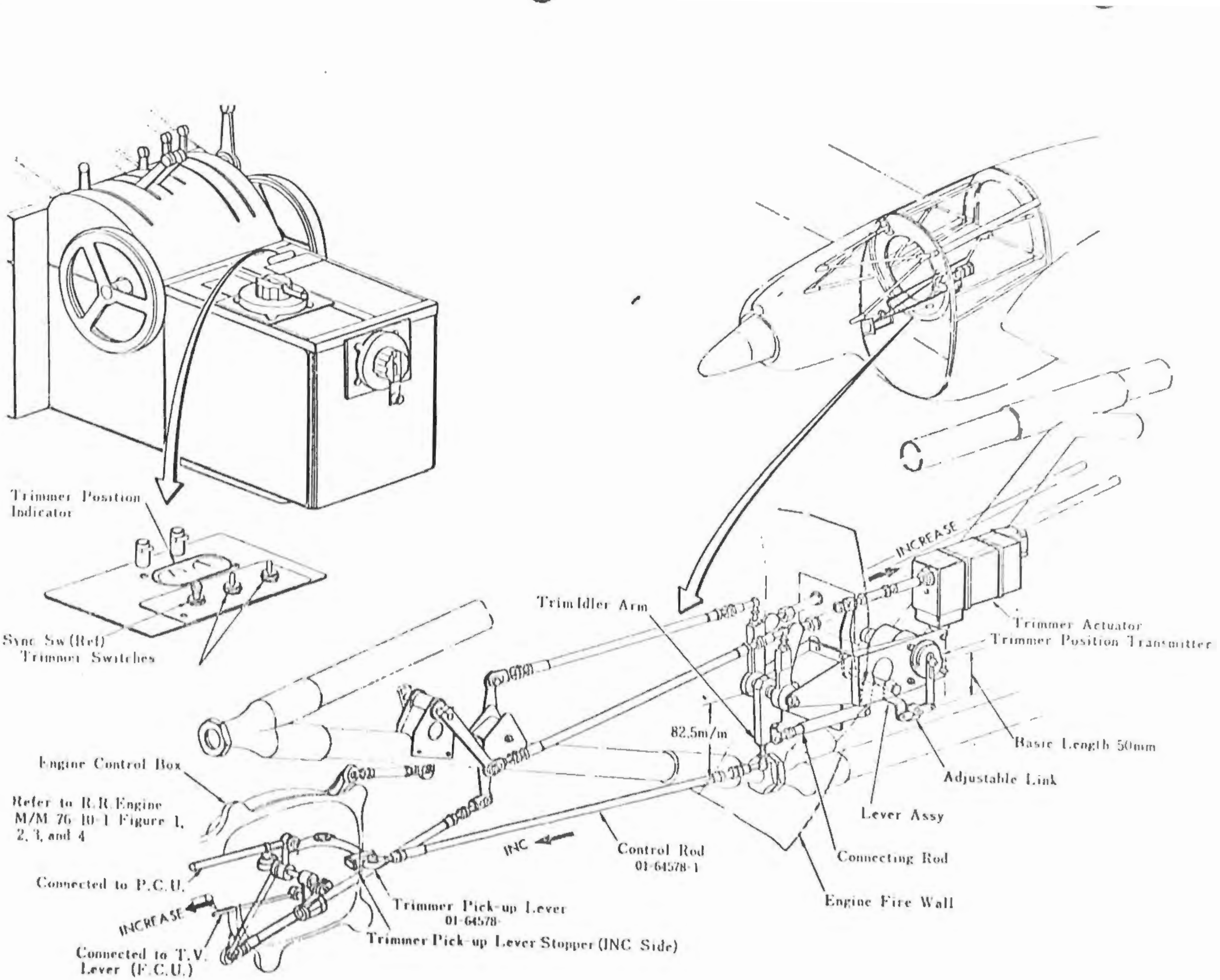
Figure 8-31



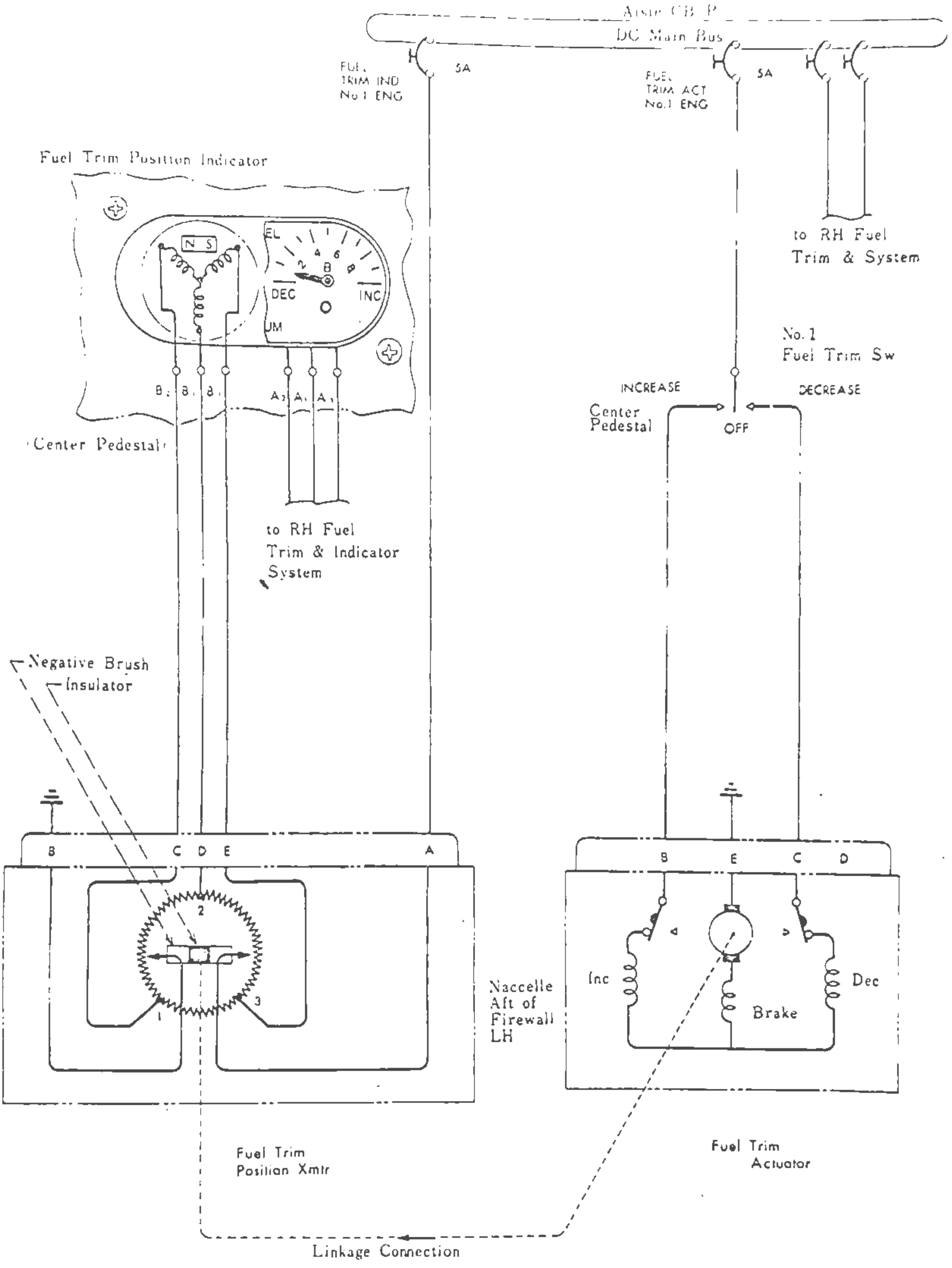
Flow (lb/h)	Alowable Tol. (lb/h)
100	±35
200	±25
400	±20
600	±10
800	±20
1,000	±25
1,200	±30
1,400	±30
1,600	±35
1,800	±35
2,000	±40



Fuel Flowmeter Transmitter
Figure 8–32

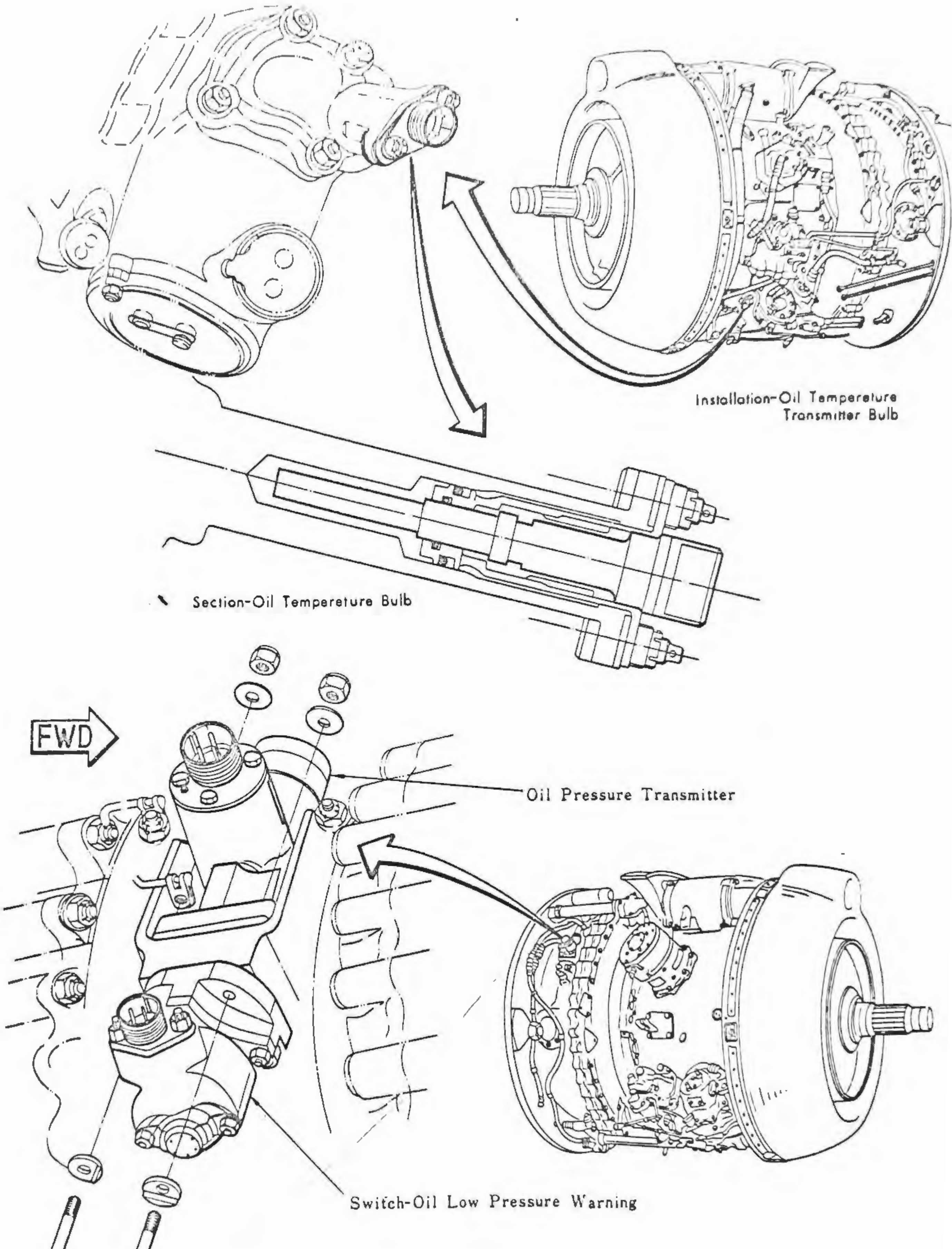


Fuel Trimmer Control System General View
Figure 8-33



Fuel Trim & Indication System Schematic

Figure 8-34



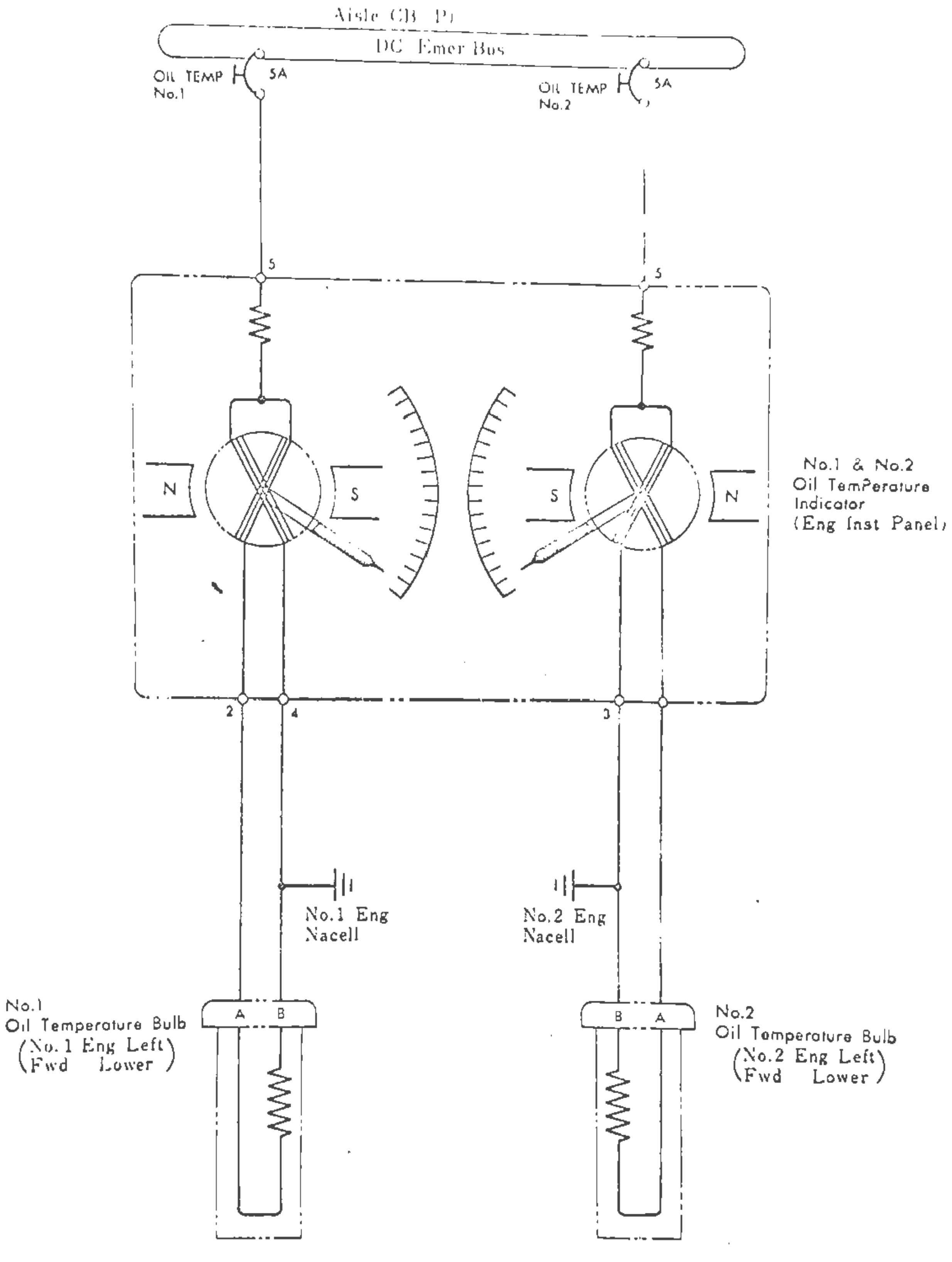
Installation-Oil Temperature Transmitter Bulb

Section-Oil Tempereture Bulb

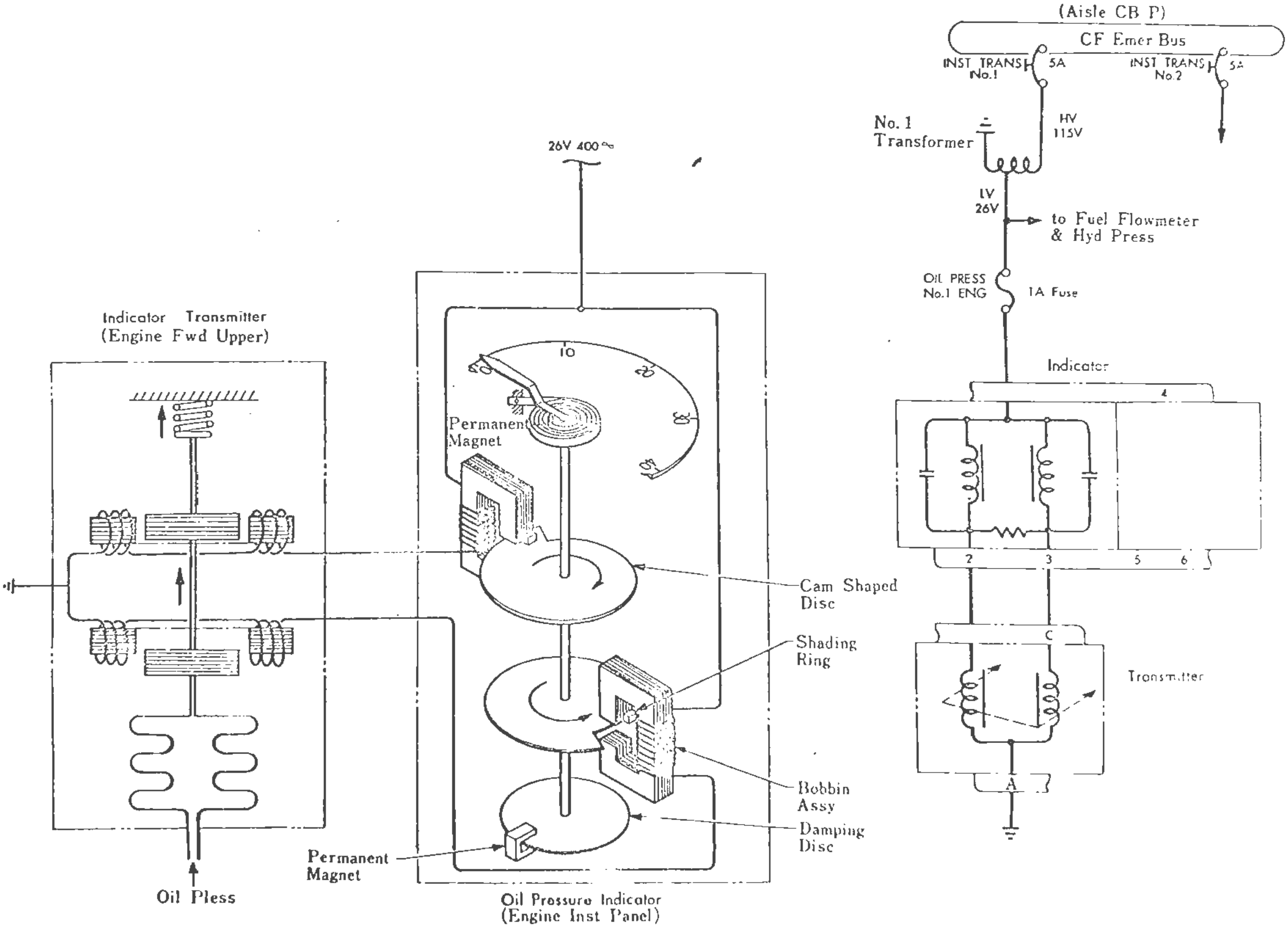
Installation-Oil Pressure Transmitter

Oil Tempereture Bulb and Oil Pressure Transmitter
and Oil low Pressure Warning Switch

Figure 8-35

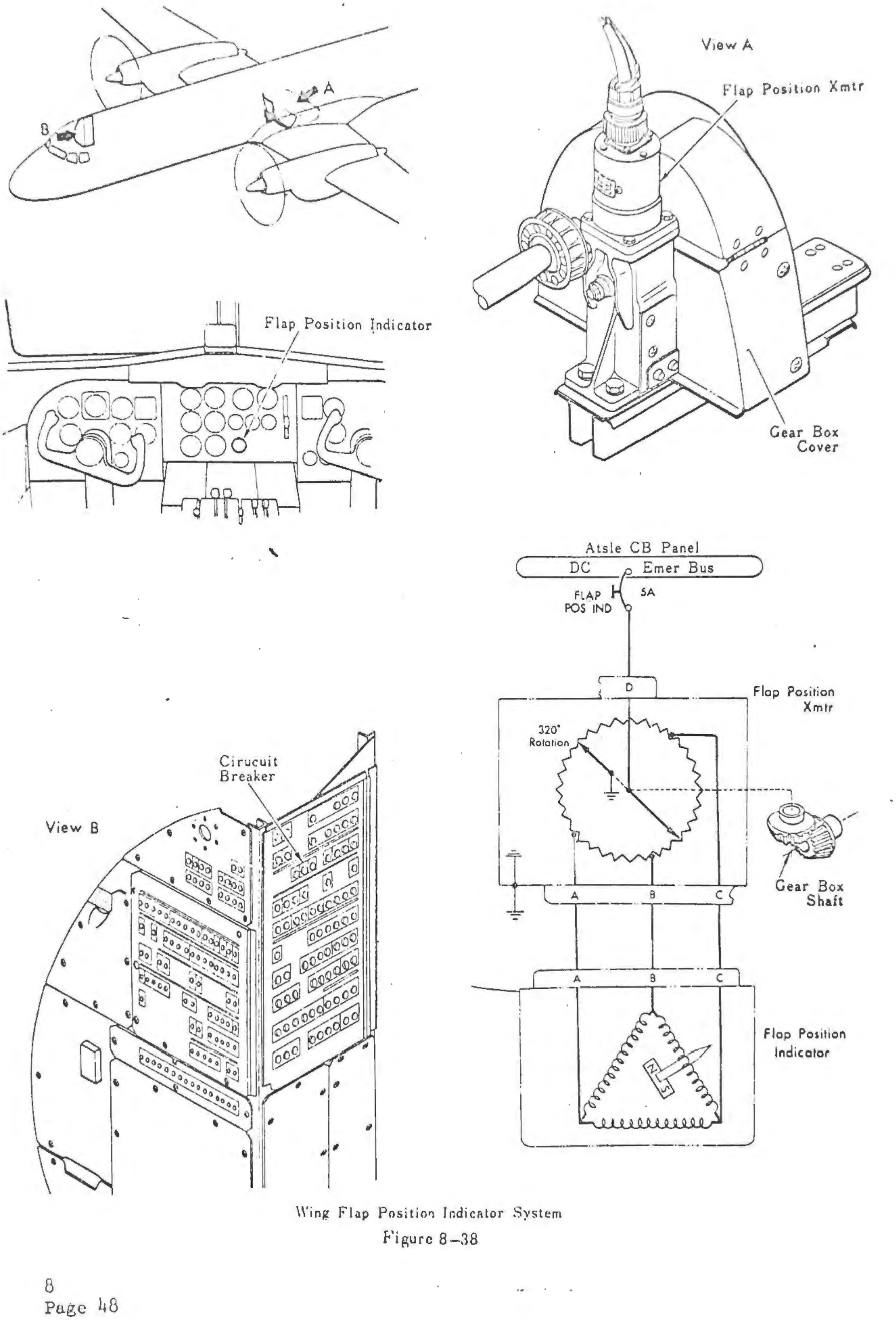

Aisle CB Pl
DC Emer Bus
OIL TEMP No.1
5A
OIL TEMP No.2
5A
5
5
N
S
S
N
No.1 & No.2 Oil Temperature Indicator (Eng Inst Panel)
2
4
3
No.1 Eng Nacell
No.2 Eng Nacell
No.1 Oil Temperature Bulb (No.1 Eng Left Fwd Lower)
A
B
B
A
No.2 Oil Temperature Bulb (No.2 Eng Left Fwd Lower)

Oil Temperature Indiction Diagram
Figure 8–36



Oil Pressure Indication Function and Theoretical Diagram

Figure 8–37



Wing Flap Position Indicator System
Figure 8–38

Chapter 9 ELECTRICAL SYSTEM

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Chapter 9 ELECTRICAL SYSTEM

9.1 General

The electrical system of the YS-11 consists of the following 3 systems:

(1) DC power supply system

(2) Constant frequency AC power supply system

(3) Wild frequency AC power supply system

The DC power supply system constitutes the master circuit of all the electrical circuits and its wiring is grounded by a single wire.

DC power source consists of two engine driven DC generators, two lead batteries and an emergency battery and supplies DC power to the loads through their respective buses.

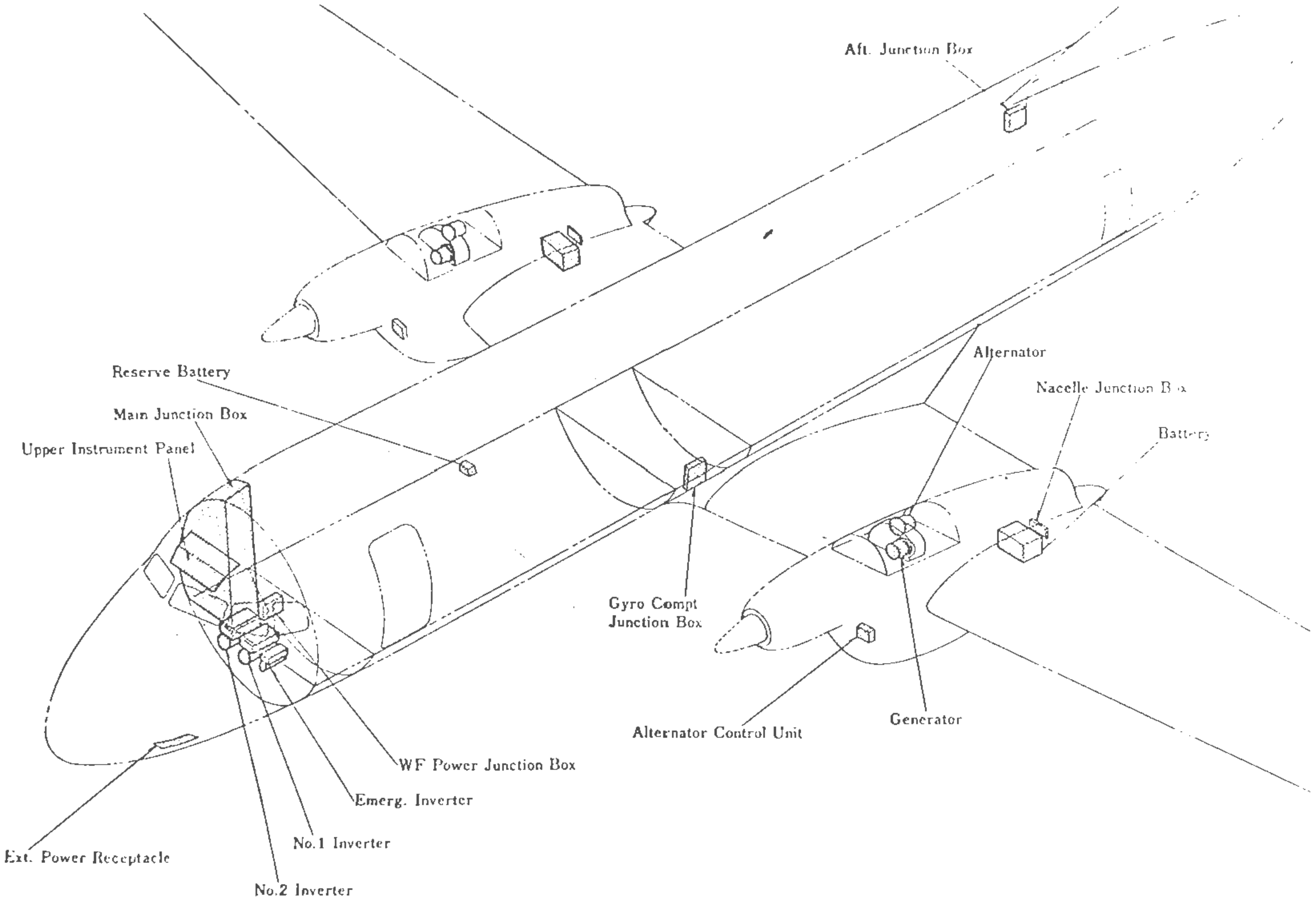
If engine starting with airborne batteries is desired, it is necessary to replace the lead batteries with 4 Ni-Cd batteries.

On the ground, external power is made available from the external power supply receptacle located at the bottom of the left hand side of the nose section of the fuselage.

The loads for which this power is used include general control circuits, heater circuits, pump and motor circuits and inverter circuits.

The constant frequency AC power supply system uses three inverters to generate 115V, 400 c/s single phase power. Power from this system is used not only for radios and instruments but also for various control circuits.

The wild frequency AC power supply system (referred to as W.F.) uses two engine driven alternators to generate 150V three phase power on the ground and 204V three phase power in flight. The power is used for de-icing engines and propellers, foot warmer, galley etc. which are not affected by the frequency variation.



Electrical Power System Lay out
Figure 9-1

9.2 DC Power Supply System

9.2.1 General

The DC power supply system consists of four systems.

(1) DC Generator System

One 12 KW DC generator is provided on each engine gear box, supplying power to the DC main bus. The voltage of the generated power is maintained automatically at 28.0 ± 0.2V in case of lead batteries and 28.5 ± 0.2V in case of Ni-Cd batteries.

(2) Battery System

24 AH lead batteries are installed 1 ea. in the L.H. and R.H. nacelles (22 AH Ni-Cd batteries are installed 2 ea. in the L.H. and R.H. nacelles of the airplanes in which engine internal starting is conducted.), supplying power to the DC emergency bus.

(3) Emergency Battery System

One 0.8AH Ni-Cd battery is installed in the belly cargo compartment, supplying power to the crash bus.

(4) External Power System

When power is supplied to the aircraft on the ground, the ground power unit is connected to the aircraft at the external power panel located on the L.H. side of the fuselage nose section, to supply power to the main bus.

(5) DC Power Distribution

The DC power supply system consists of the main bus, emergency bus and crash bus, connected to normal loads, emergency loads and fire extinguishing circuits, respectively.

9.2.2 Operation of DC Power Supply System

(1) When External Power Supply System is connected to Main Bus

After connecting the external power supply to the external power supply panel, start the external power supply. Place the battery switch in "EXT." Then, the external power light comes on, indicating that the external power supply is connected to the main bus. Its voltage can be read on the voltmeter.

(2) When Battery is connected to Emergency Bus

If the battery switch is placed in "BATTERY," the battery power supply is connected to the emergency bus. Its voltage can be read on the voltmeter.

(3) When DC Generator is connected to Main Bus

When the engine is running at idling speed, the generator is generating DC power but the power is not supplied to the main bus yet. If the generator switch is turned on, the contactor cuts in automatically, permitting the generated power to be fed to the main bus and its voltage can be read on the voltmeter. The voltage is, of course, maintained at a certain voltage by the automatic voltage regulator. If something goes wrong, the system is tripped by protective devices against over-voltage, grounding failure and reverse current, cutting its connection to the main bus and the generator fail light comes on.

If the fail light is on when the generator is not in operation, the contactor must be faulty.

9.2.3 DC Generator

12KW engine driven generators are installed 1 ea. on the gear boxes of the L.H. and R.H. engine nacelles, generating and supplying DC power to the main bus. The generator has four terminals; "A, B, C, and D," "A" being (A) an exciting winding terminal, "B" a DC power supply + terminal, "D" an equalizer terminal and "E" a DC power supply - terminal.

As cooling air, ram air is led through the duct from the intake located on the right side of the nacelle and blown out from the right hand side outlet through the exhaust duct after cooling the generator.

Furthermore, the engine bleed air is led into the duct of the outlet and is accelerated by the jet effects of the cooling air exhaust to accomplish forced ventilation.

The generator rating is given below:

Voltage	30V
Ampere	400A
Speed	3000 to 8000 rpm
Weight	65 lbs
Model	G29-7BT
MFR	Jack & Heintz

The brush is 1-1/8" long and replace it if it becomes less than 5/8".

The spring tension is 2.5 to 4.5 lbs.

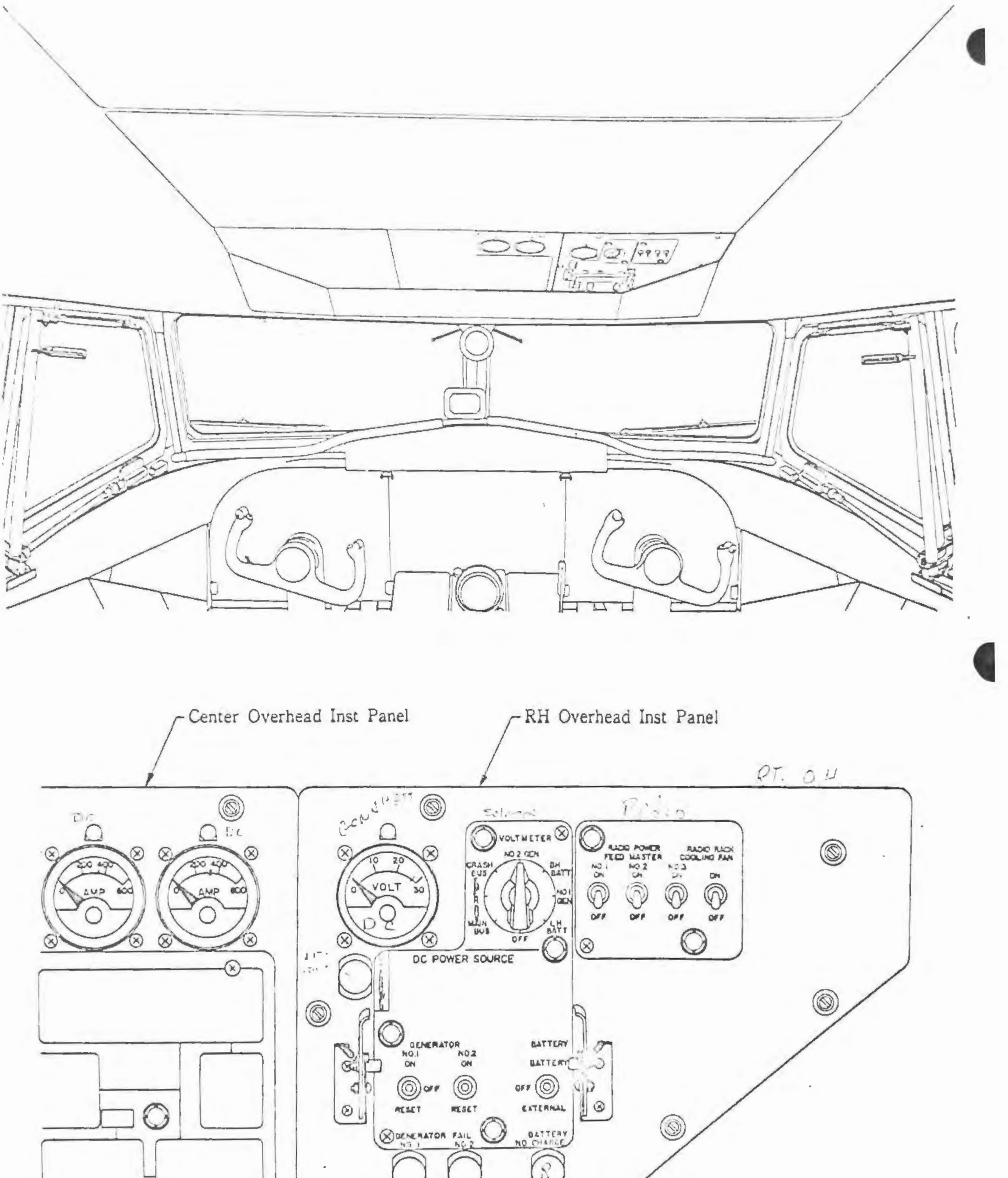
9.2.4 Control Panel

In the electrical compartment is provided a control panel to regulate the voltage and to protect the generator. This panel is mounted on the airframe through shock mounts and has the following functions:

(1) Automatic Voltage Regulation

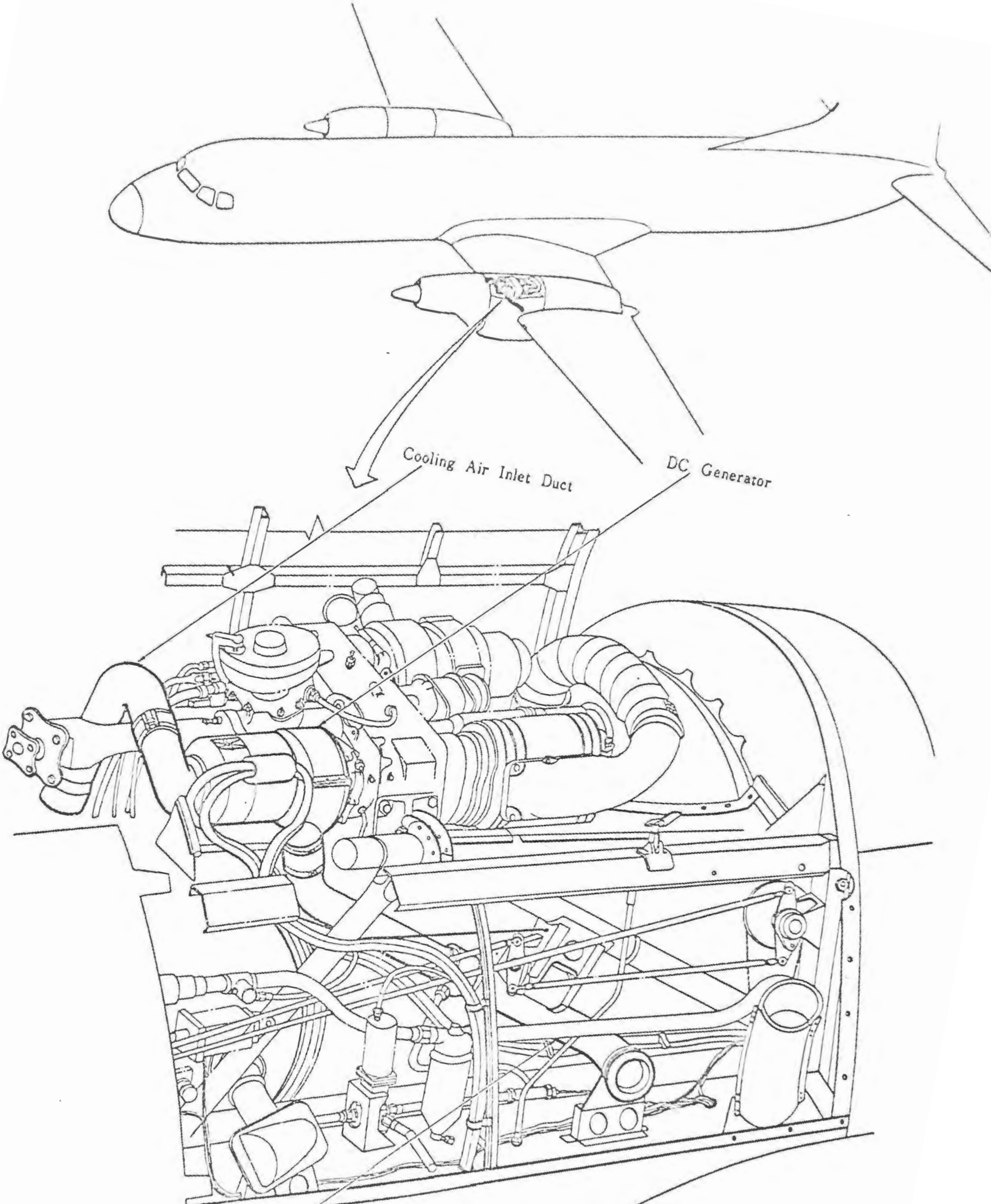
To maintain the voltage constant regardless of the load current.

Lead battery	28.0 ± 0.2V
Ni-Cd battery	28.5 ± 0.2V

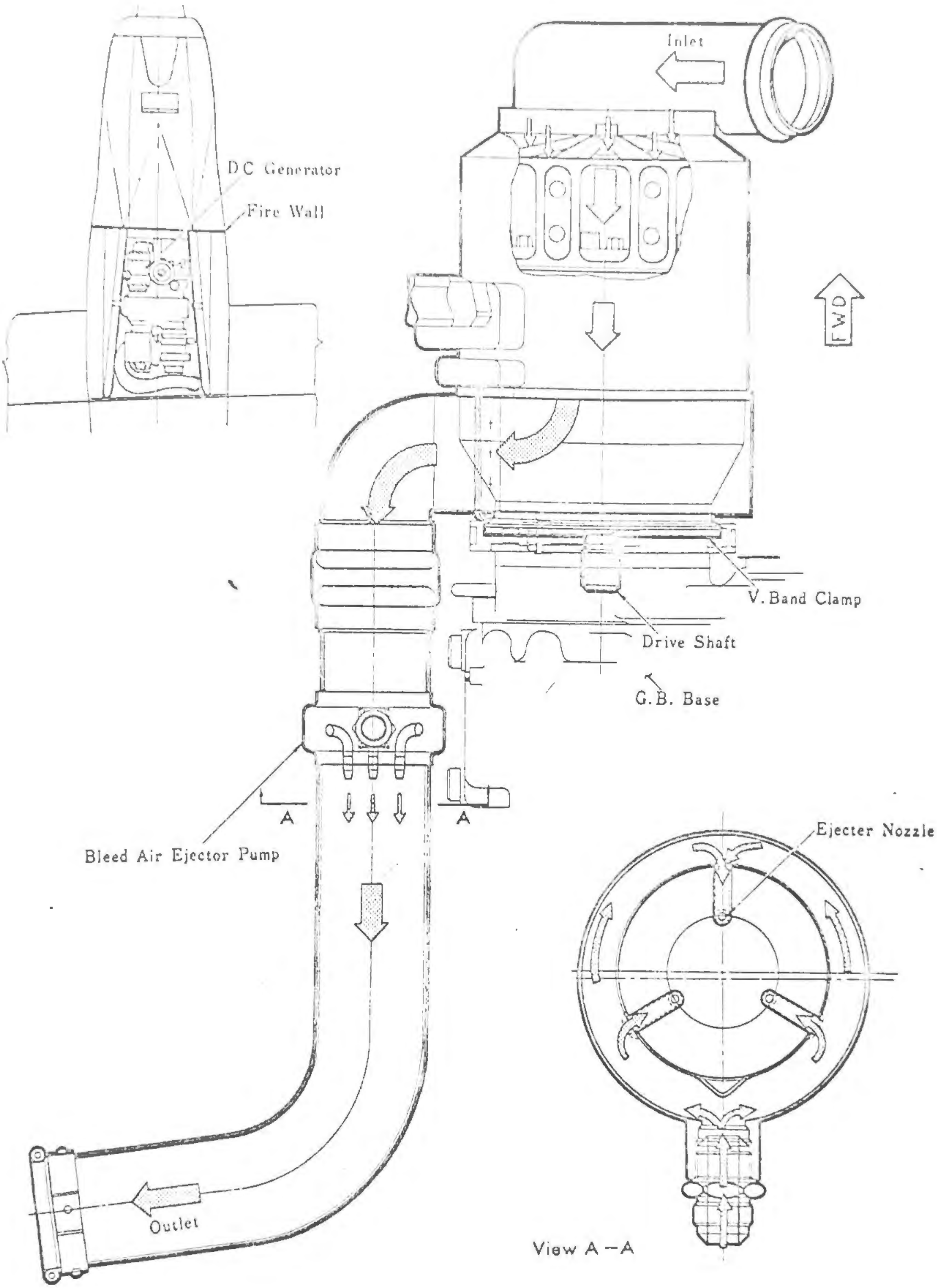


DC Power Indication

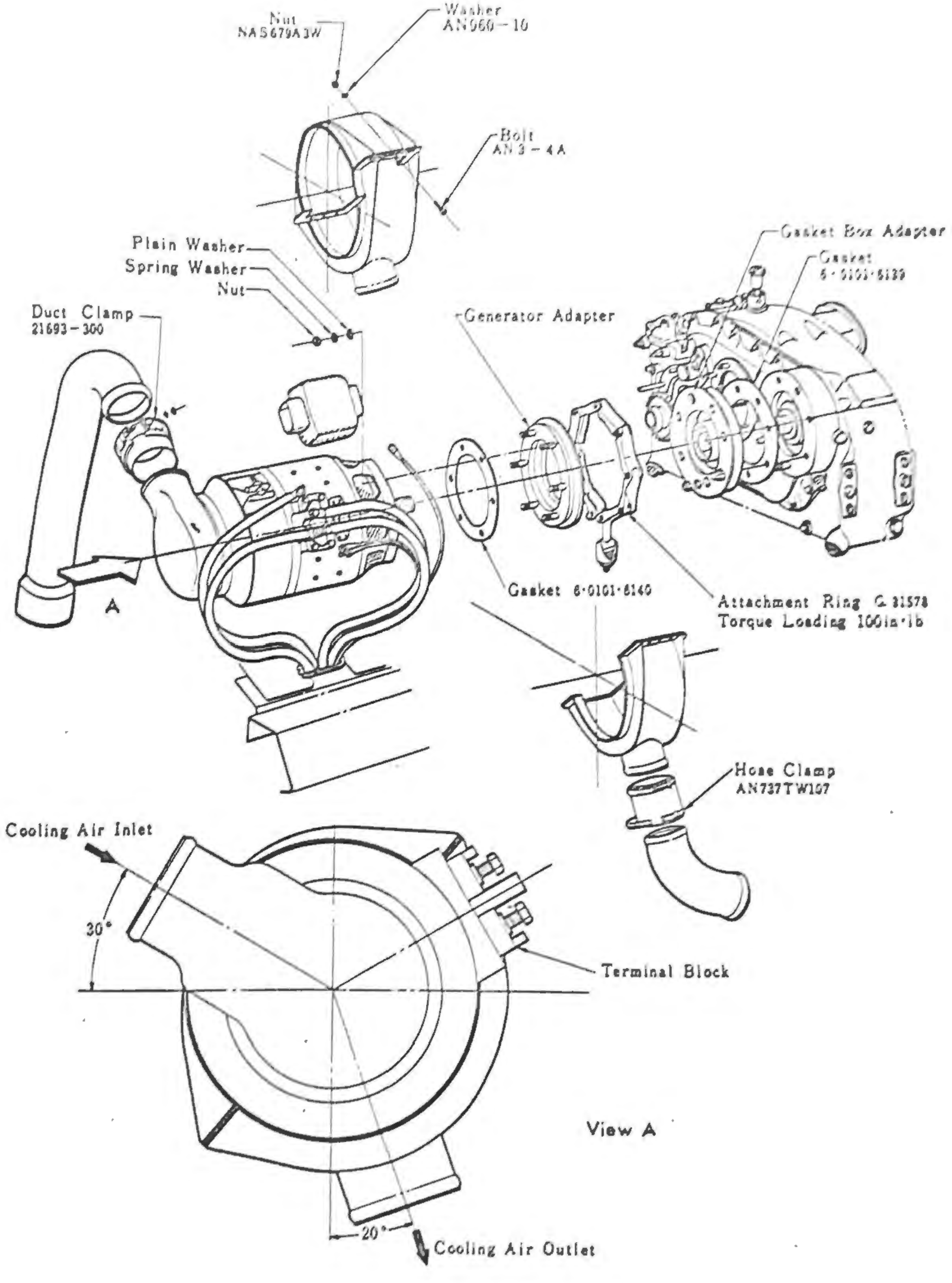
Figure 9–3



DC Generator Installation
Figure 9–4



DC Generator Cooling
Figure 9—5



D.C Generator Removal/Install

Figure 9-6

(2) Parallel Operation

To equalize the load shares of No. 1 and No. 2 generators, the difference between the two being set at 20 Amp.

(3) Automatic Engagement

To connect the generator voltage to the main bus when it becomes 0.35 to 0.70 V higher than the voltage of the main bus.

(4) Protection against Inverse Polarity

To trip the generator when the generator terminal B becomes - and the terminal E becomes +.

(5) Protection against Overvoltage

To trip the generator when the generator voltage reaches 32 to 34V.

(6) Protection against Faulty Grounding

To trip the generator when the feeder is grounded.

(7) Protection against Reverse Current

To trip the generator when the reverse current reaches 10 Amp. and the voltage at the terminals of the reverse current relay becomes 0.12 to 0.2V. The adjustment of the generator voltage can be made by the variable resistor of the voltage regulator located on the forward fuse panel.

9.2.5 Battery

Two 24V, 24AH lead batteries are installed 1 ea. in the rear of the engine nacelles. In case of airplanes which are capable of internal engine starting, 22AH Ni-Cd batteries are installed 2 ea. in the rear of the nacelles.

The batteries are connected in parallel to the DC emergency bus and power is supplied from the batteries to the emergency bus if the battery switch is placed in "BATT." The batteries are always charged to the full as long as the D.C generators are in operation. However, the batteries can not be charged by the ground power supply. The batteries are ventilated by ram air. That is to say, the ram air entered the air intake along the battery cover leaves the exhaust port after ventilation of the batteries. The batteries can be removed or installed easily by means of the battery elevators.

5.2.5 Components Installed in the Tank - Integral (See Fig. 5-2)

Following components are installed in each wing.

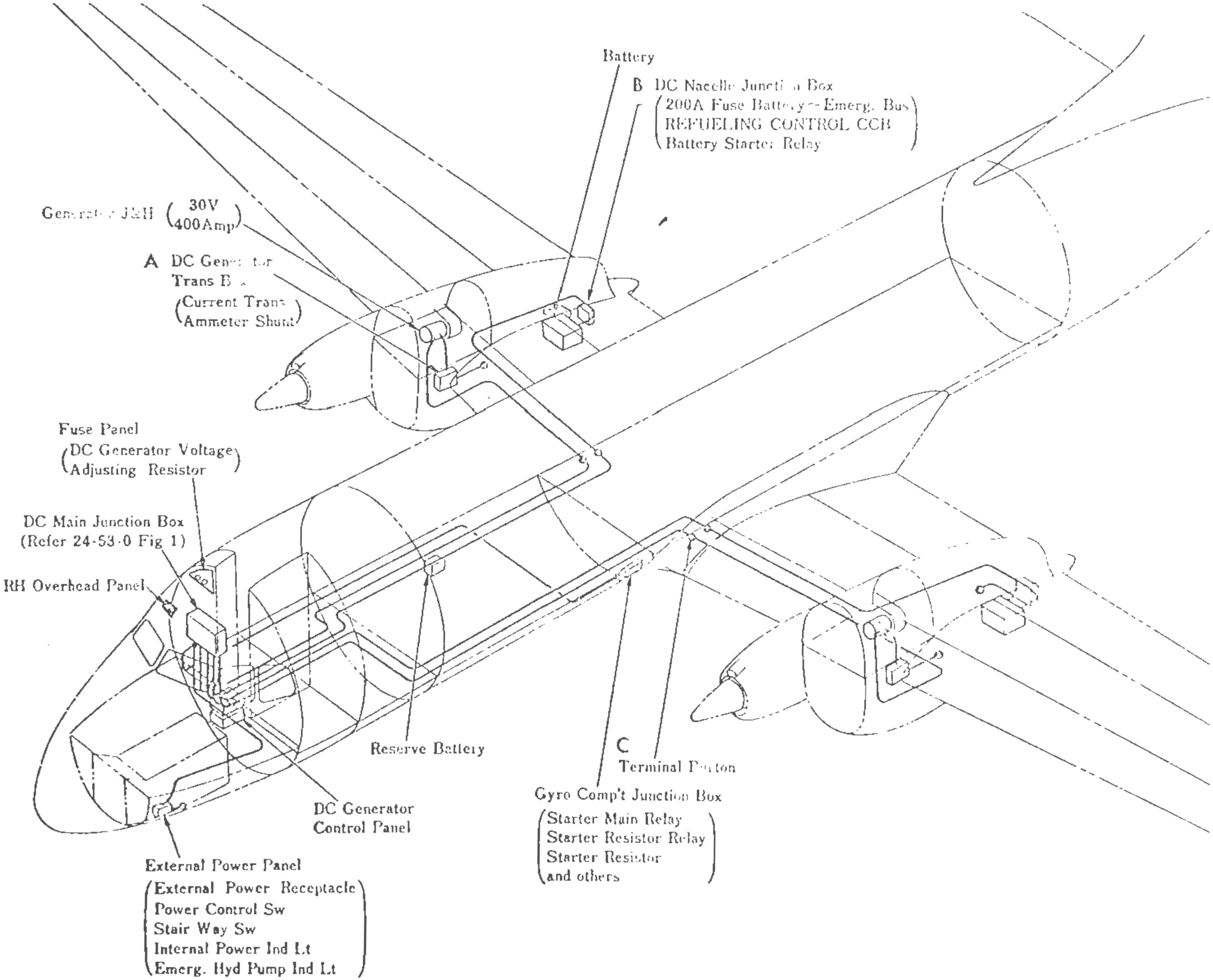
Installed Component	Quantity
Fuel Booster Pump	2
Collector Tank	1
Scavenge Pump Inlet Screen	2
Direct Reading Type Fuel Quantity Sight Gage	2
Tank Unit	3
Compensator	1
Over Wing Filler	1
Pressure Relief Valve	1
Vent Float Valve	1
Float Switch	1
Tank Drain Valve	2

(1) Construction and Operation of Filler and Vent of the Tank

A. Over Wing Filler (See Fig. 5-4)

This is a manually operated, Lock and Unlock marked, airtight cap made by Roylyn, U.S.A.

The neck which forms principal part of the cap is riveted to the cylindrical filler pan. The pan is riveted to the upper wing surface. A cover plate provided with a latch is attached to the pan in even level with the wing surface.



DC Generation Components Layout
Figure 9-2

9.2.6 Ni-Cd Battery

The battery consists of 19 cells including polar plates good for rapid discharging, nickel oxide anode and cadmium cathode. The electrolytic fluid is 30% potassium hydroxide solution. Its capacity is 22AH (2 hour discharge rate). Although the measurement of the specific gravity of the electrolytic fluid of this battery is not necessary, the periodic measurement of the fluid level is required. The level should be 1.5 to 3 mm from the upper end of the polar plate. As for charging the batteries, they are charged up to 36AH with 8A charging current. During the charging period, the voltage is 25.6 to 27.75V but it rises to 30.4 to 32.3V at the final stage of charging and then becomes constant. After the voltage reaches the constant value, the batteries are charged by 8AH before the charging is stopped but they should not be charged in excess of 36AH.

9.2.7 Emergency Battery

An emergency battery to be used in case of crash is installed in the belly cargo compartment. This battery of small capacity of 0.8AH is used to power the fire extinguishing system.

This battery is always kept charged by generators, external power supply or batteries and it is fully charged if the voltage is in excess of 24.5V.

9.2.8 External Power Source

On the L.H. side of the forward fuselage is located the external power supply receptacle which takes DC 28V power from the ground power unit and supplies it to the main bus.

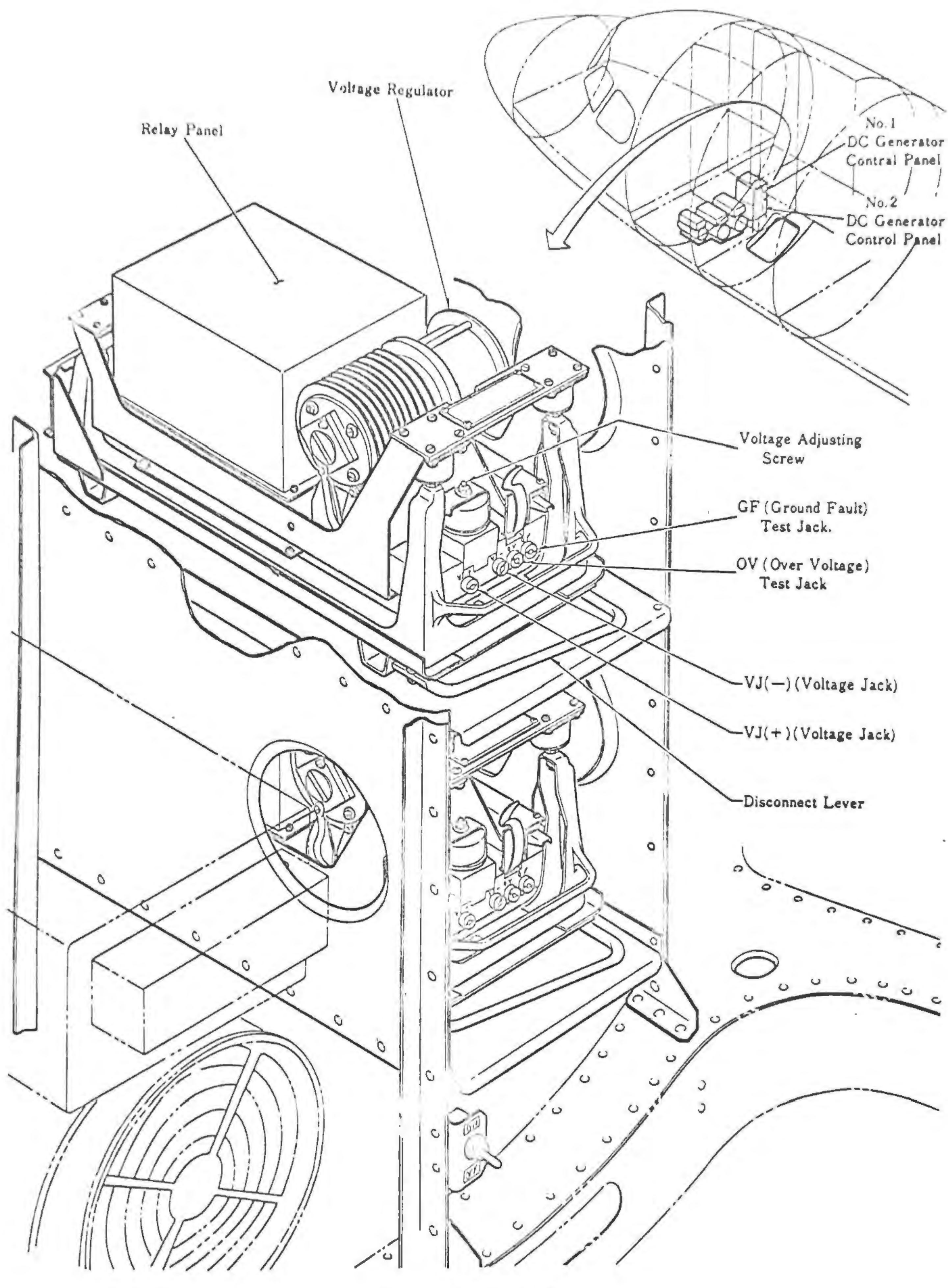
The external power supply panel is provided with two receptacles, power control, momentary switch for the stairway control and two indicator lamps. 2 receptacles are connected mutually in parallel, preventing the pins from being overheated.

After inserting the plug of the ground power unit into the aircraft and starting the engine, select the voltage and place the battery switch in "EXTERNAL." Then, the ground power unit supplies power to the main bus and the external power light comes on. However, if one or more D.C. generators start operation, the power supply from the ground power unit is cut off. That is to say, the D.C. generators and the ground power unit can not run in parallel.

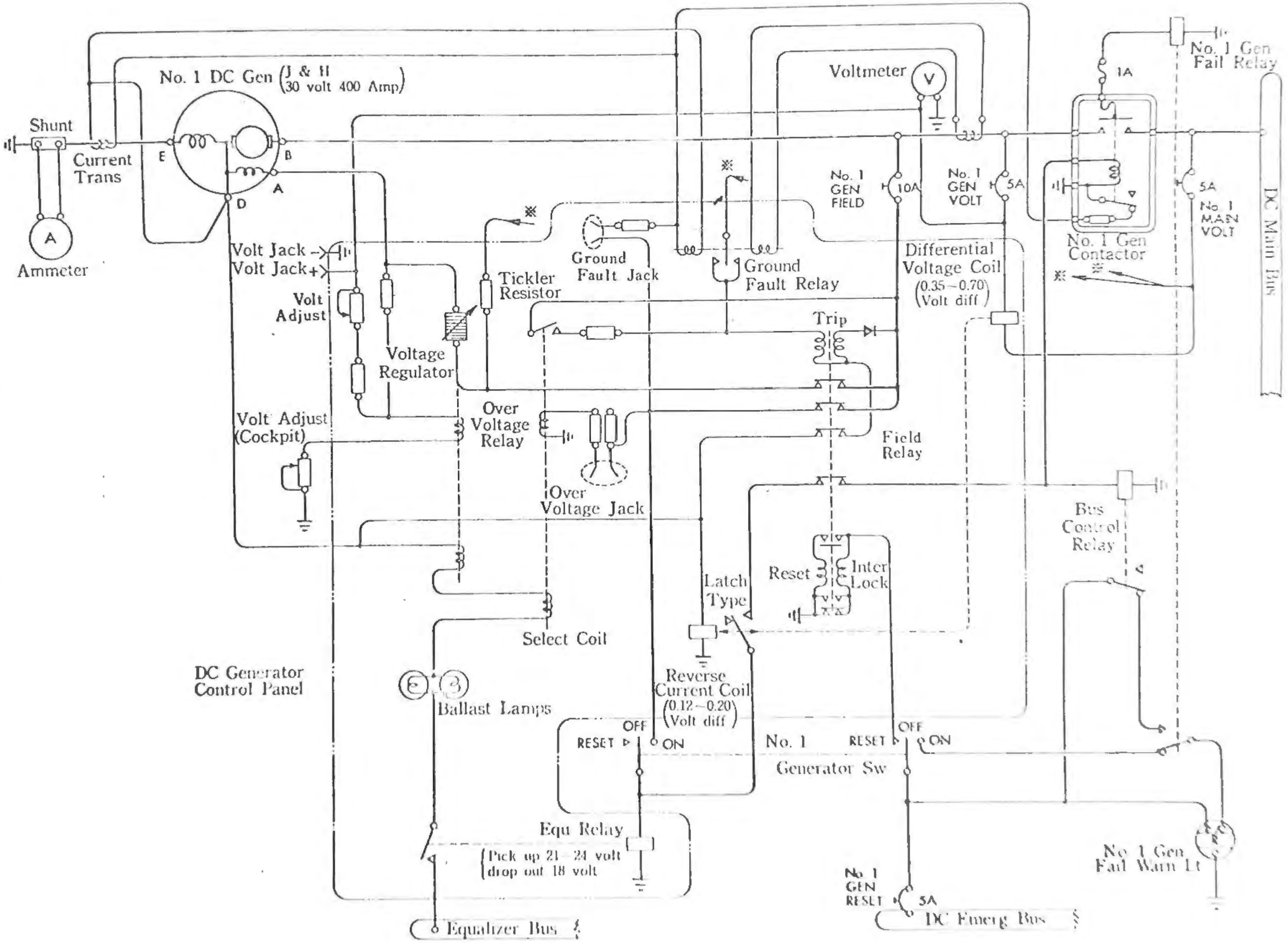
The power control switch located on the external power supply panel is used to control the power for the stairway. When the batteries are used, set it to "BAT." When the ground power unit is used, set it to "EXT." When the batteries are used, the "Internal Power Light" is on.

9.2.9 Buses

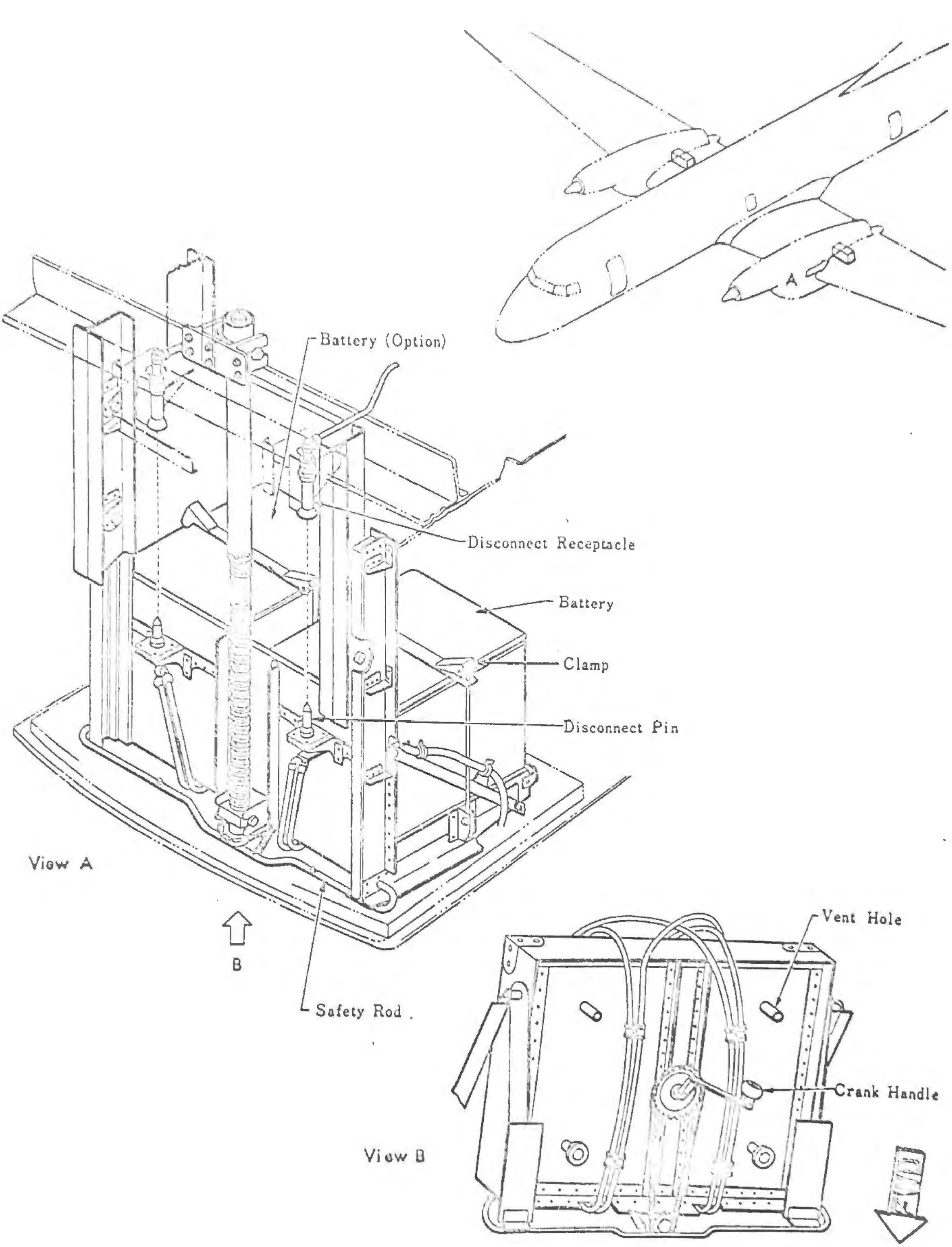
The D.C. buses include the main, emergency and crash buses. The crash bus to which power is supplied from the emergency battery is connected to the fire extinguishing system for the engines and wing heaters, and to the starting control relay.



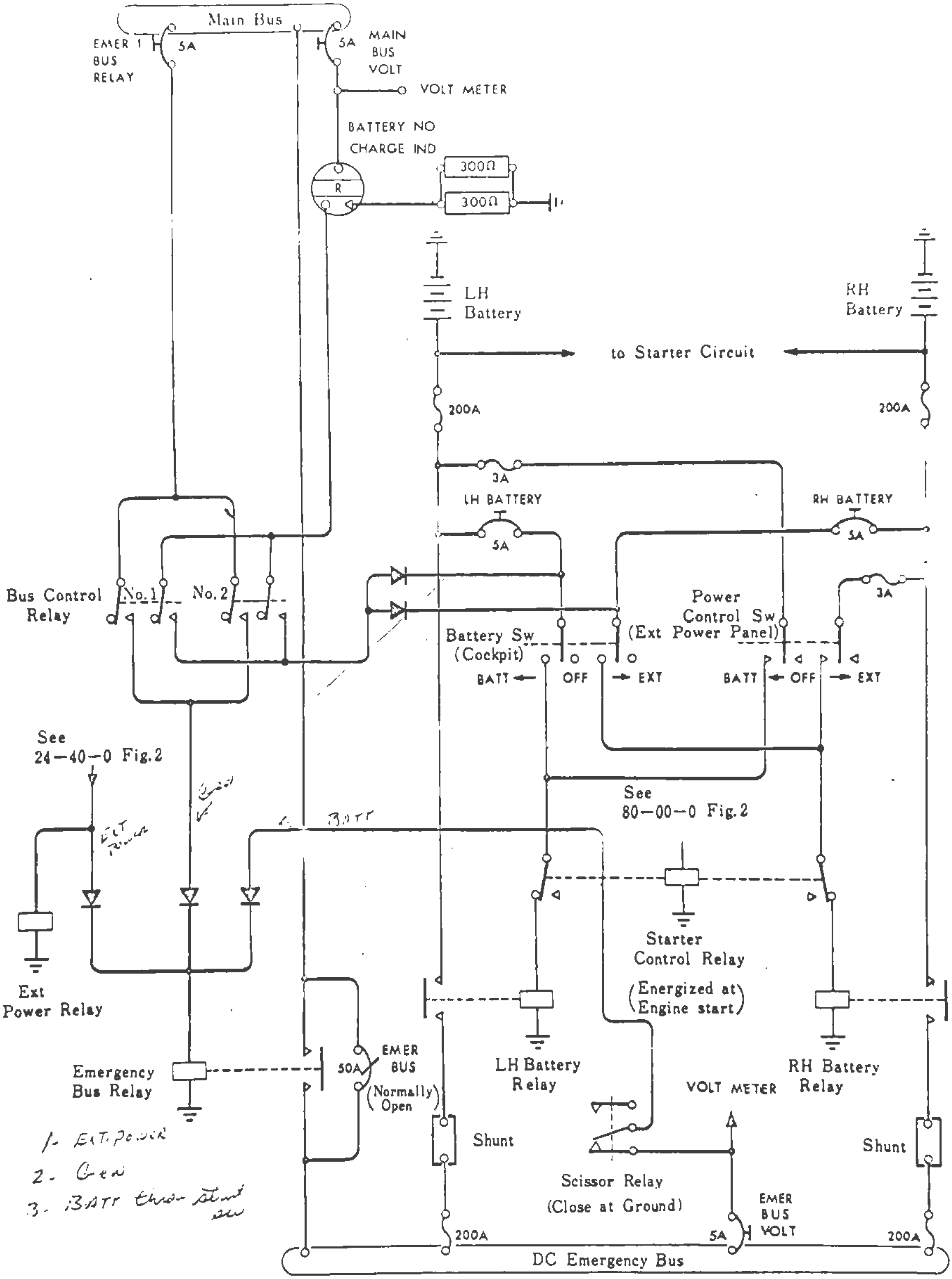
DC Generator Control Panel
Figure 9–7



DC Generation Schematic
Figure 9–8



Buttery Installation and Elevator Fitting
Figure 9–9



Source

1- Ext. Power

2- Gen

3- BATT thru start sw

D.C Emergency Bus Control Schematic

Figure 9-10

The emergency bus to which power is supplied from the batteries is connected to the loads indispensable for continuance of flight; emergency inverter, emergency radios, essential lights etc.

The main bus to which power is supplied from the generators or the external power supply is connected all loads other than the emergency loads.

Between the main bus and the emergency bus are located the emergency relay contacts which are always closed under the following conditions:

(1) When the aircraft is on the ground.

(2) When the ground power unit is in use.

(3) When one or both generators are operating.

(4) When the starter master switch is set to "START" or "BLOW OUT."

When the emergency bus relay is out of order, the "BATTERY NO CHARGE WARNING LIGHT" is on. In such a case, the 50A emergency bus circuit breaker should be set in.

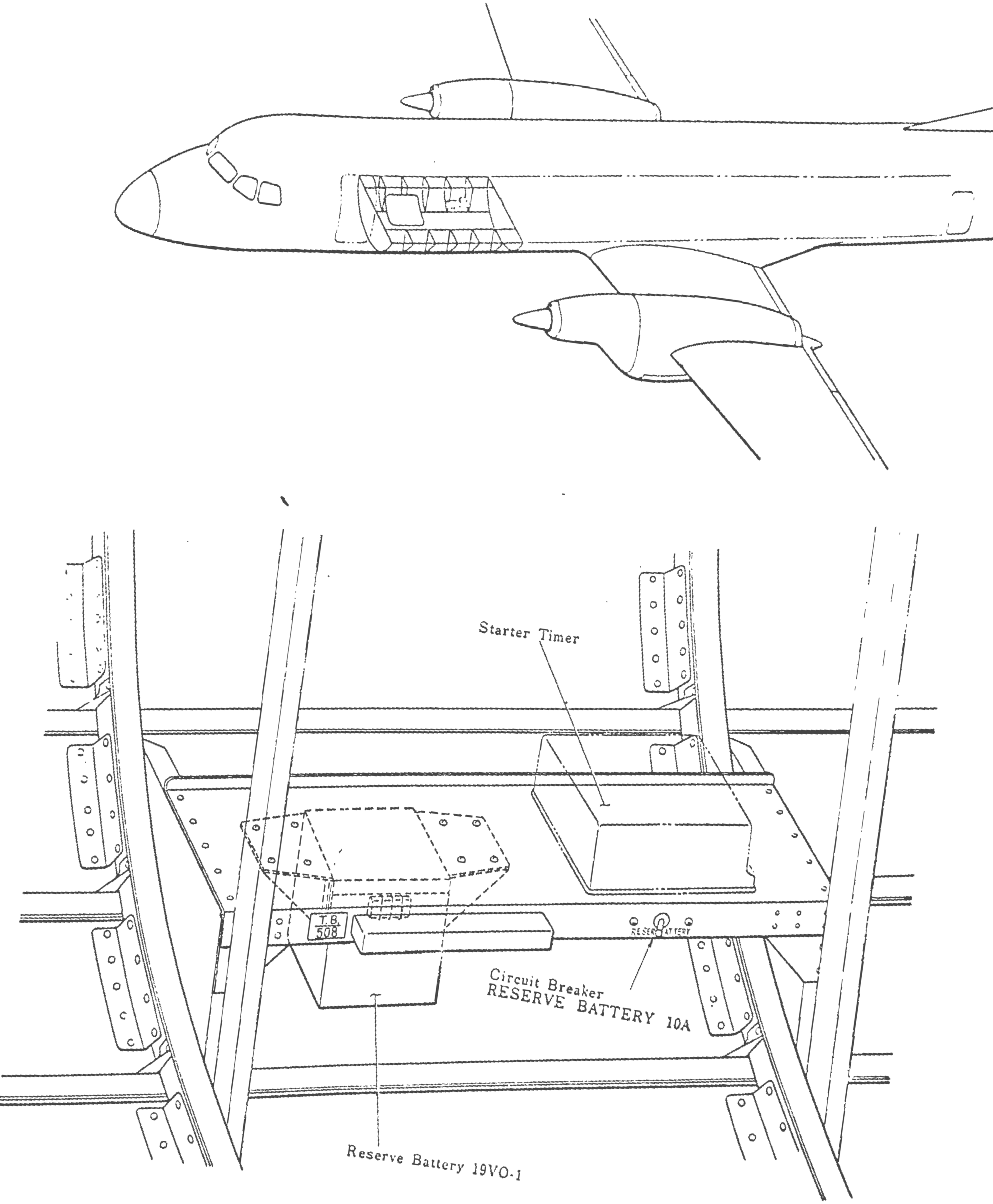
9.3 Constant Frequency AC Power Supply System

9.3.1 General

The constant frequency AC power supply consists of 3 inverters installed in the electrical compartment. Two 2500VA inverters and a 500VA inverter are all set to 115V, 400 c/s. Their output voltages can be read on the AC voltmeters installed on the overhead instrument panel. Also on the main instrument panel are installed two power fail warning lights and a main bus fail light on the overhead instrument panel. These lights tell the pilots whether power is being supplied to the emergency bus or the main bus, respectively.

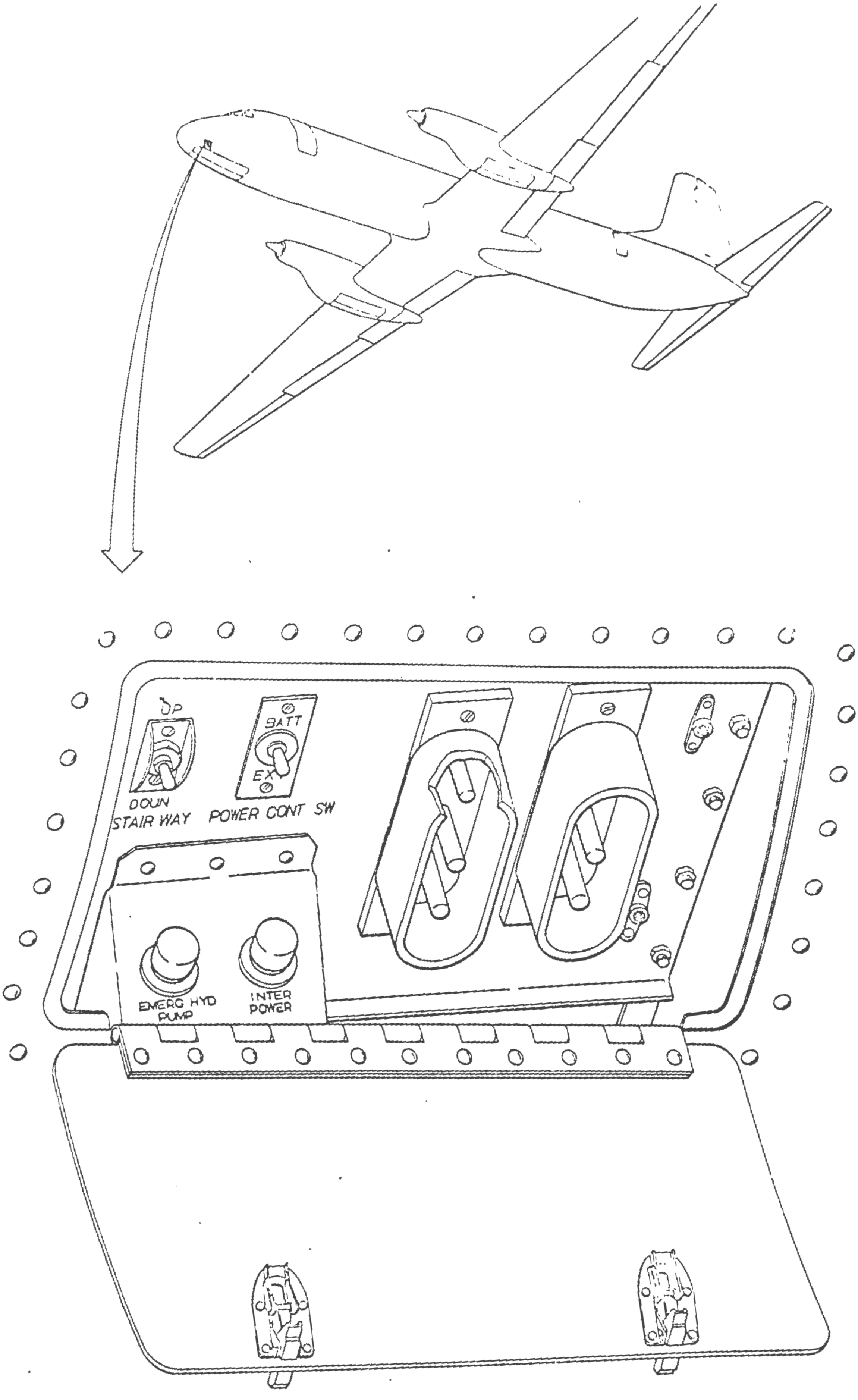
9.3.2 Operation of Constant Frequency AC Power Supply

The constant frequency AC power supply system consists of three buses.
To the emergency bus are connected the essential radios and instruments.
To the main bus are connected the non-essential radios and instruments.
To the weather radar bus are connected the weather radar & auto pilot.
On the overhead instrument panel are located three inverter switches; NO 1, NO 2 & emergency, main bus failure warning light(red), weather radar bus failure light(amber), voltmeter selector & voltmeter. If NO 1 inverter switch turned on, the main bus failure warning light goes out and power is supplied to the main bus, emergency bus, IIS-1 bus, & IIS-2 bus.
The same thing happens when NO 2 inverter switch independently is on. When both NO 1, NO 2 inverter switches are on, output of NO 1 inverter is supplied to the main bus & the emergency bus, output of NO 2 inverter is supplied to the weather radar bus, IIS-1 & IIS-2 bus. When the emergency inverter switch only is on, the power is supplied to the emergency bus & the IIS-1 bus.
When the three inverters are operated, NO 1 inverter is supplied to the mai
bus & emergency bus, NO 2 inverter is supplied to the weather radar bus, IIS-1 & IIS-2 bus, while the emergency inverter idle.

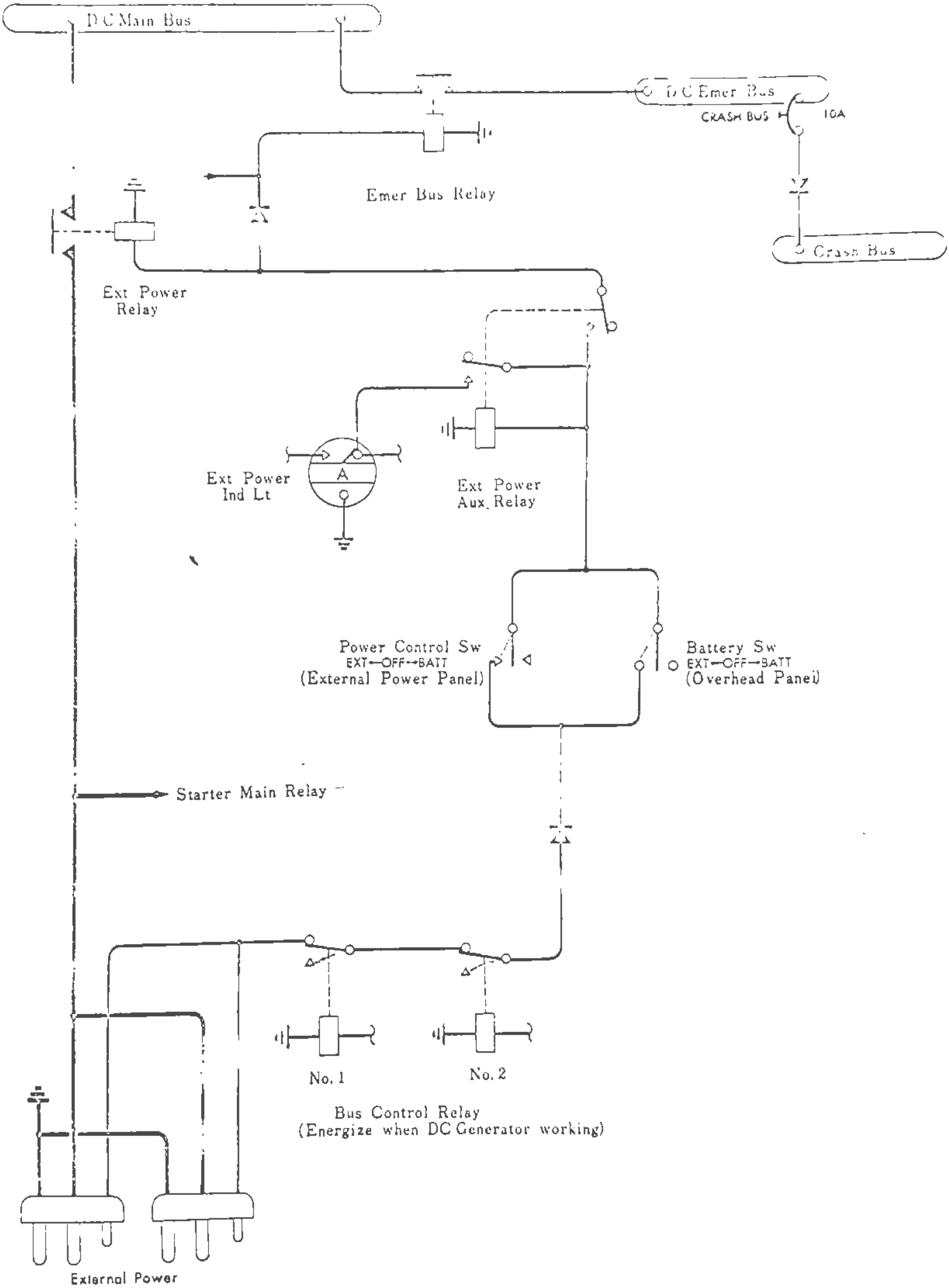


Reserve Buttery

Figure 9–11

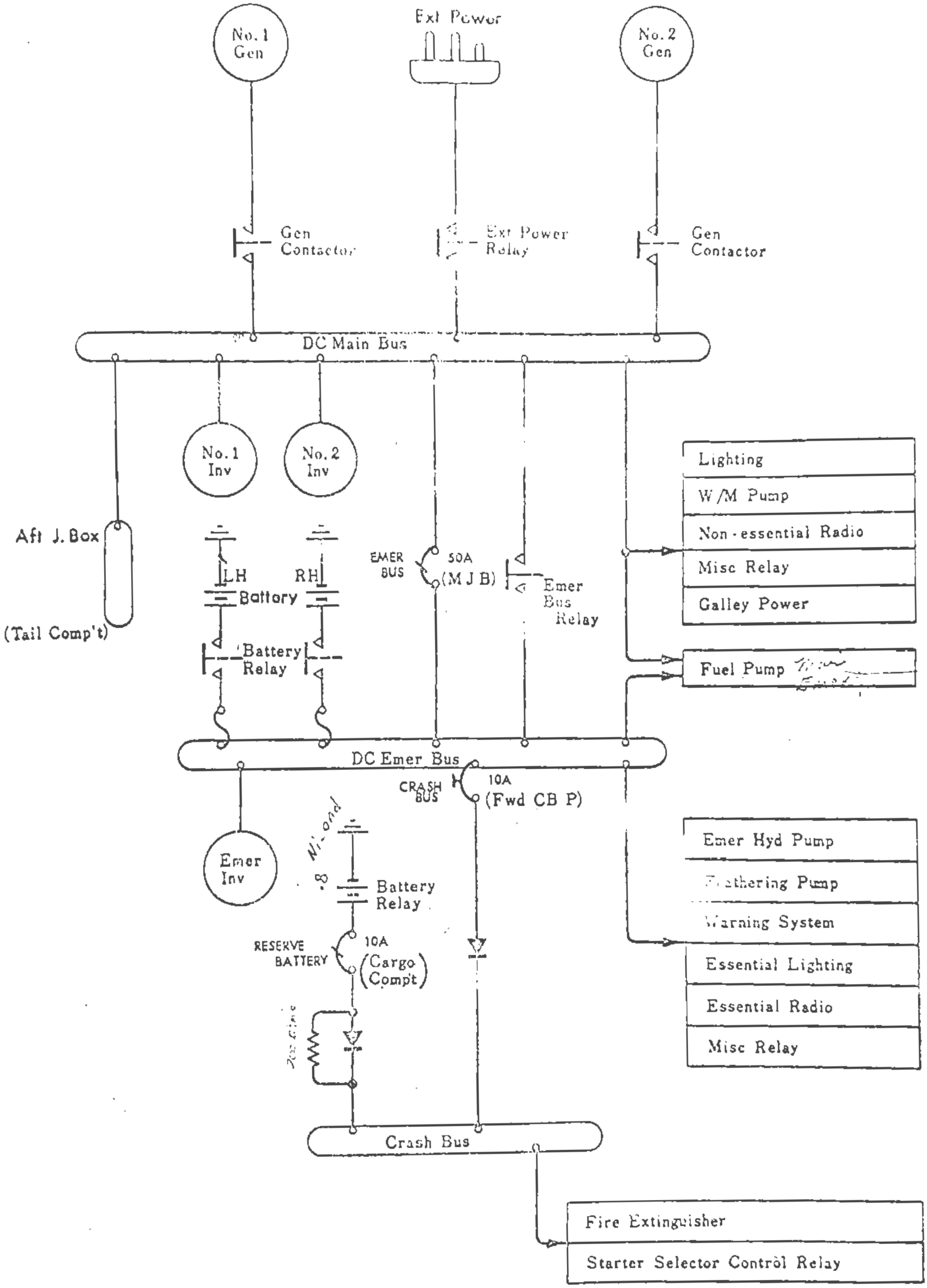


External Power Panel
Figure 9–12



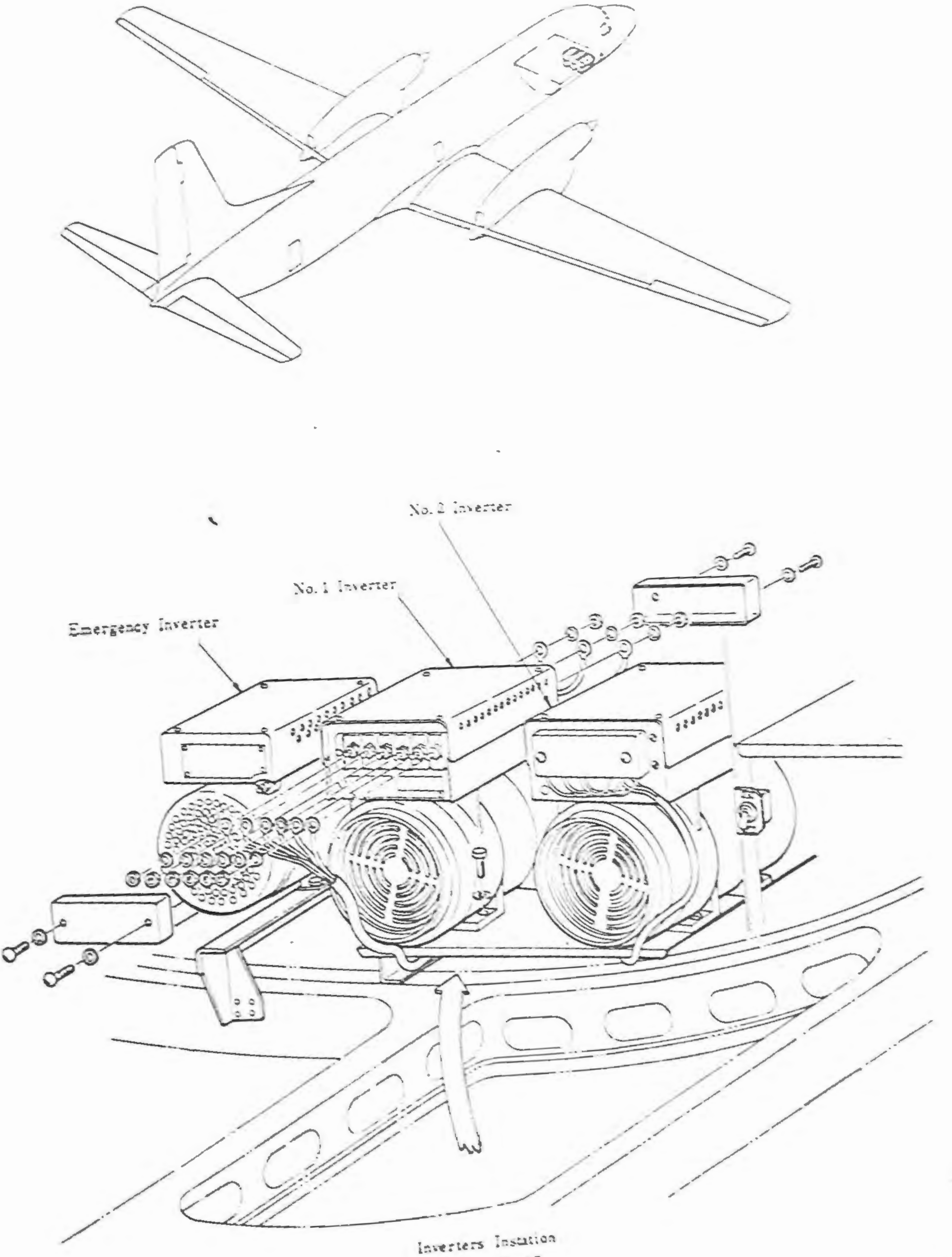
External Power Schematic

Figure 9–13



DC Power Distribution Schematic

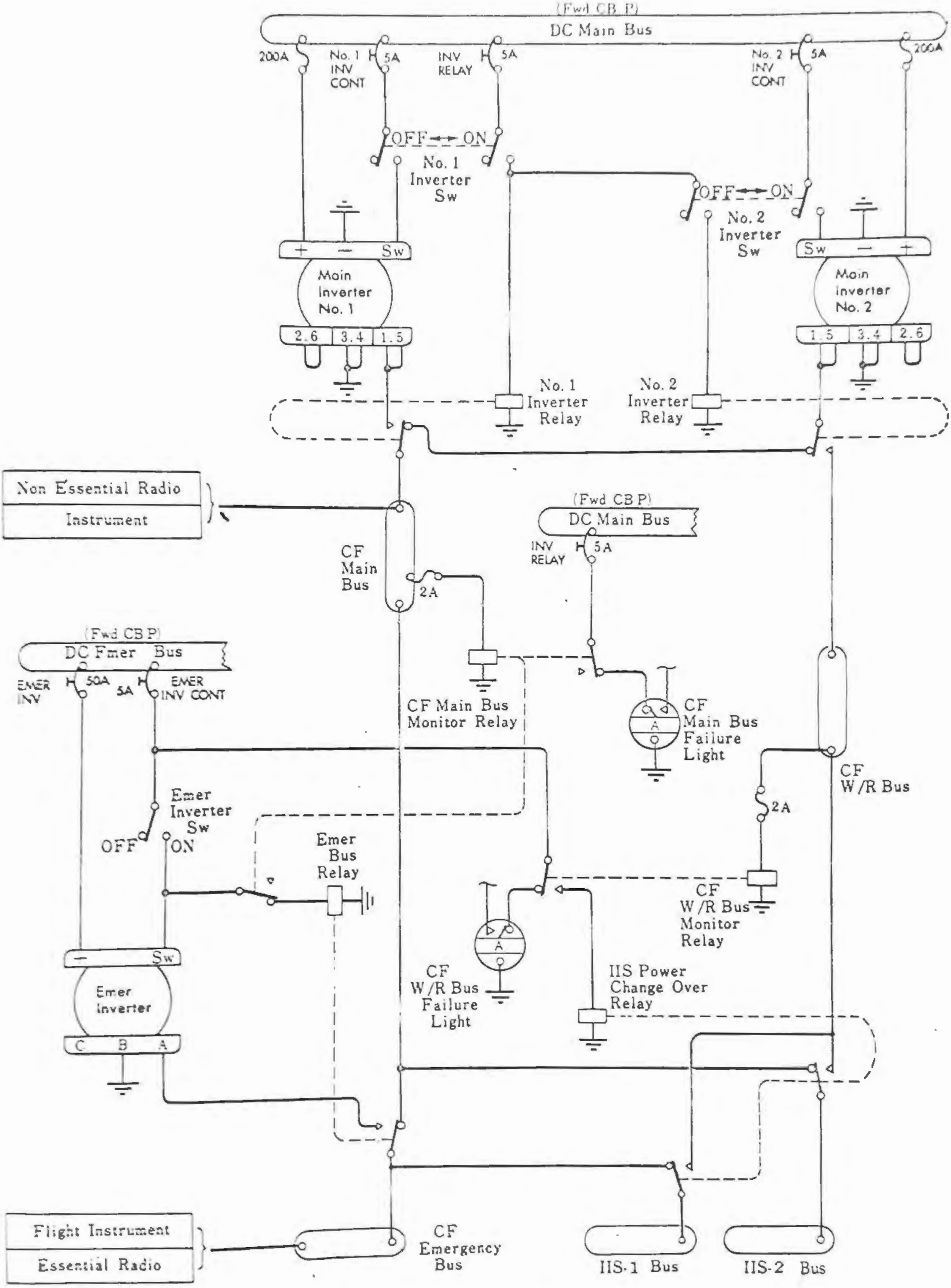
Figure 9–14



Inverters Instation
Figure 9–15

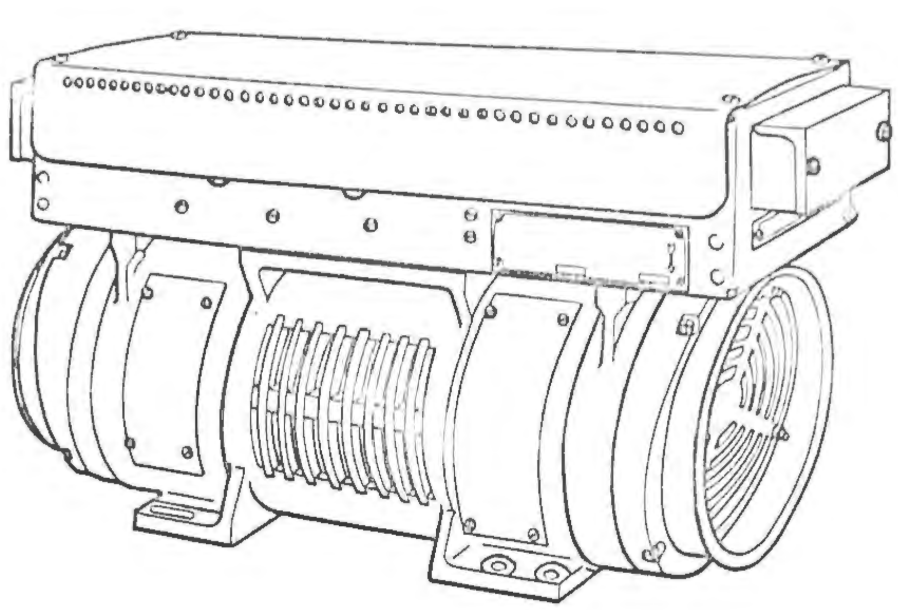
Deleted

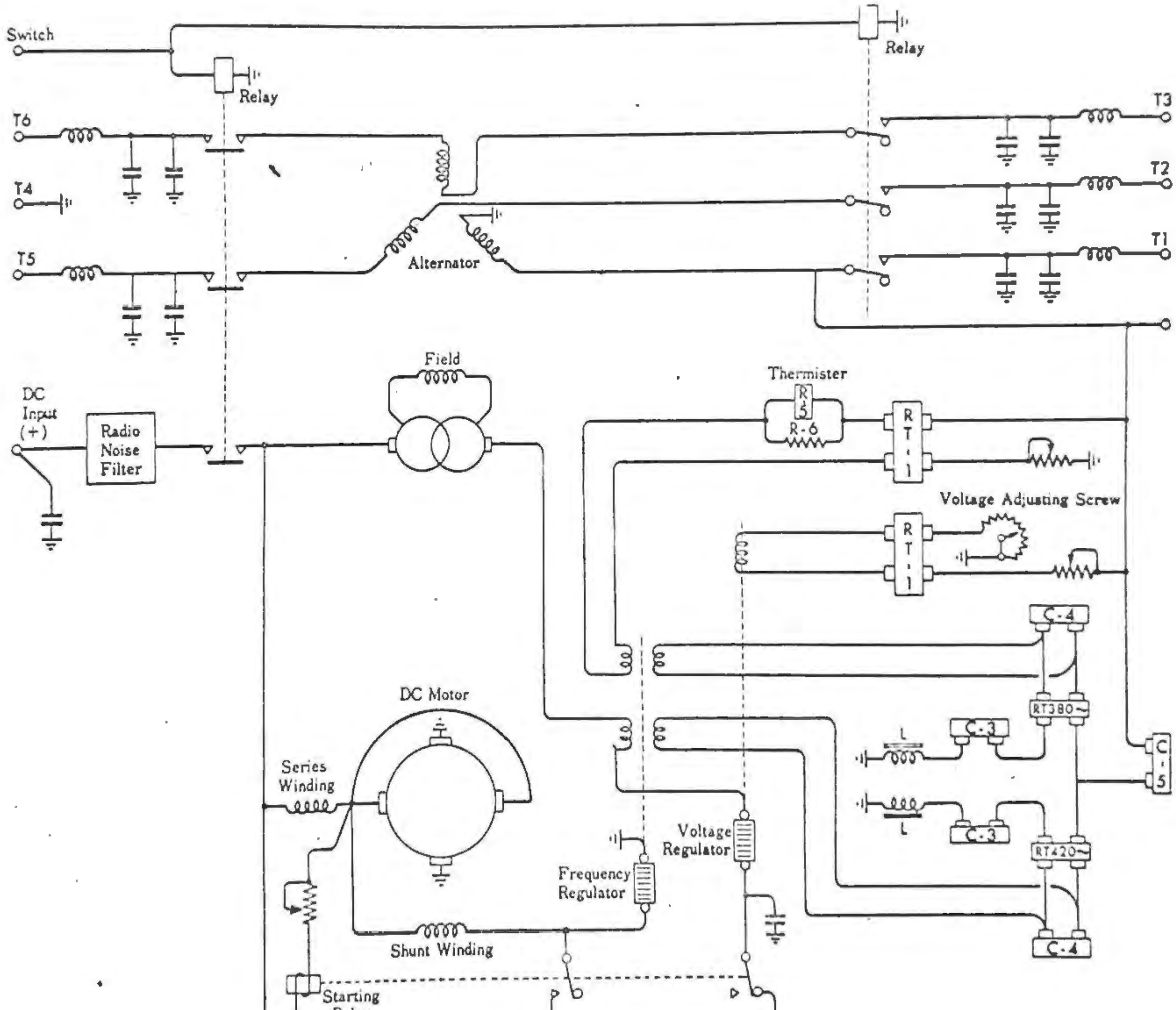
Figure 9-16



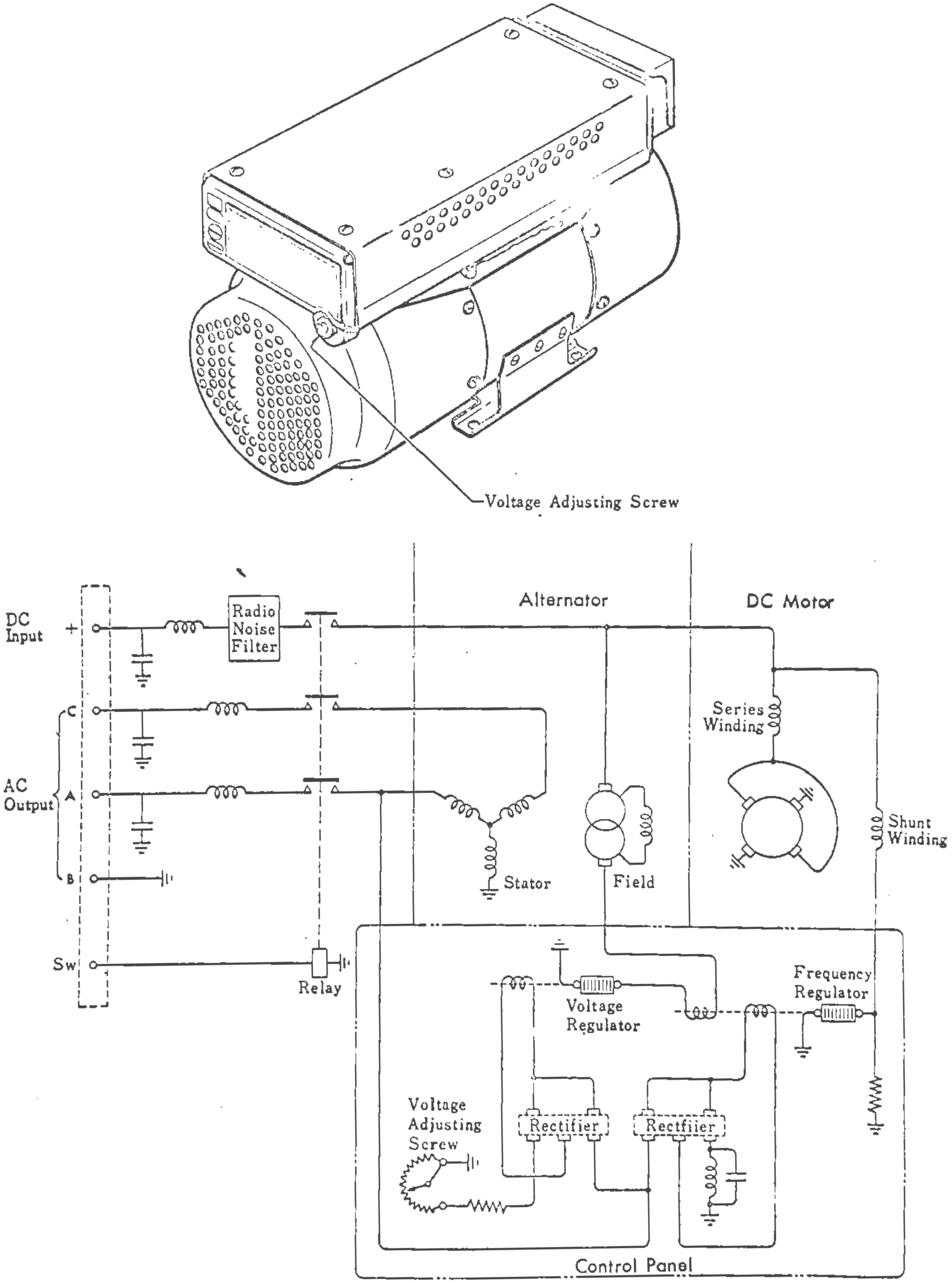
CF Power Distribution Schematic

Figure 9-16a





Main Inverter
Figure 9–17



Emergency Inverter
Figure 9–18

9.3.3 Main and Emergency Inverters

The output of these inverters is automatically regulated to 115V ± 5%, 400 c/s, being supplied to loads through noise filters. The wiring is of single phase wiring.

The output of the main inverters and the emergency inverter is 2500VA and 500VA, respectively. Each inverter can be adjusted by a screw on the voltage regulator located outside the inverter.

9.4 Wild Frequency AC Power Supply System (WF Power Supply)

9.4.1 General

The wild frequency power is sent to No. 1 and No. 2 buses by engine driven alternators. This power is supplied to heaters which are not affected by frequency variation; deicing of engines and propellers, foot warmer and galley power. When one alternator is faulty, the other alternator can supply power to the above loads.

9.4.2 Operation of WF Power

When the engines are running and the D.C. generators are operating, supplying power to the D.C. main bus, the alternators are ready to generate power. If the alternator switches are turned on, the alternators generate and supply power to the main bus. Then, the failure light goes out. If there is a cause for low voltage or earth leak in the circuit, the earth leak light comes on. When power supply to the failed generating system, turn on the transfer switch. The relation between the engine speed and the frequency of the alternator power is shown below:

LS Lever Position	Line Voltage	Engine Speed	Alternator Speed	Frequency
Ground	150V ± 4%	6500 rpm to 10725 rpm	3940 rpm to 6500 rpm	195 c/s to 325 c/s
Flight	204V ± 4%	9900 rpm to 15015 rpm	6000 rpm to 9100 rpm	300 c/s to 455 c/s

9.4.3 Alternator

The alternators are installed 1 ea. on the engine gear boxes.

This alternator is of six-pole rotary field type. In the initial stage of power generation, it must be excited externally but it becomes self-exciting later. This switching is carried out by the control unit.

This control unit also set the voltage to 150V on the ground and 204V in flight. This switching is carried out by the low stop lever. As the output of the alternator increases, its cooling becomes necessary. To cool the alternator, cooling air is taken from the interior of the nacelle and blown out from the nacelle.

The specification of the alternator is shown below:

Maximum output	27KVA (6000 rpm)
Line voltage	204V
Line current	74.9A
Power factor	0.8
Direction of rotation	Clockwise viewed from the driving end
Phase rotation	A-B-C viewed from the driving end
Weight	55 lb (25 Kg)

9.4.4 Control of Alternator

A control units is provided in each of the L.H. and R.H. nacelles (landing gear compartments). This control unit has the following functions:

(1) Automatic Voltage Regulation

A constant voltage is always maintained, irrespective of the amount of the load current. That is to say, the voltage sensing circuit senses the irregular voltage, the error magnetic amplifier and the power magnetic amplifier amplify it and the current limiter controls the field current.

(2) Protection against Overvoltage

If the voltage becomes 225 $^{+5}_{-0}$V or 170 ±5V in case of the alternator voltage of 204V or 150V, respectively, the alternator trips, dropping the generated voltage to zero.

(3) Feeder Protection

If there is unbalance of 10A between the feeders of the alternators or unbalance of 5A between the feeders and the earth, the alternator trips, dropping the generated voltage to zero.

(4) Earth Leak Indication

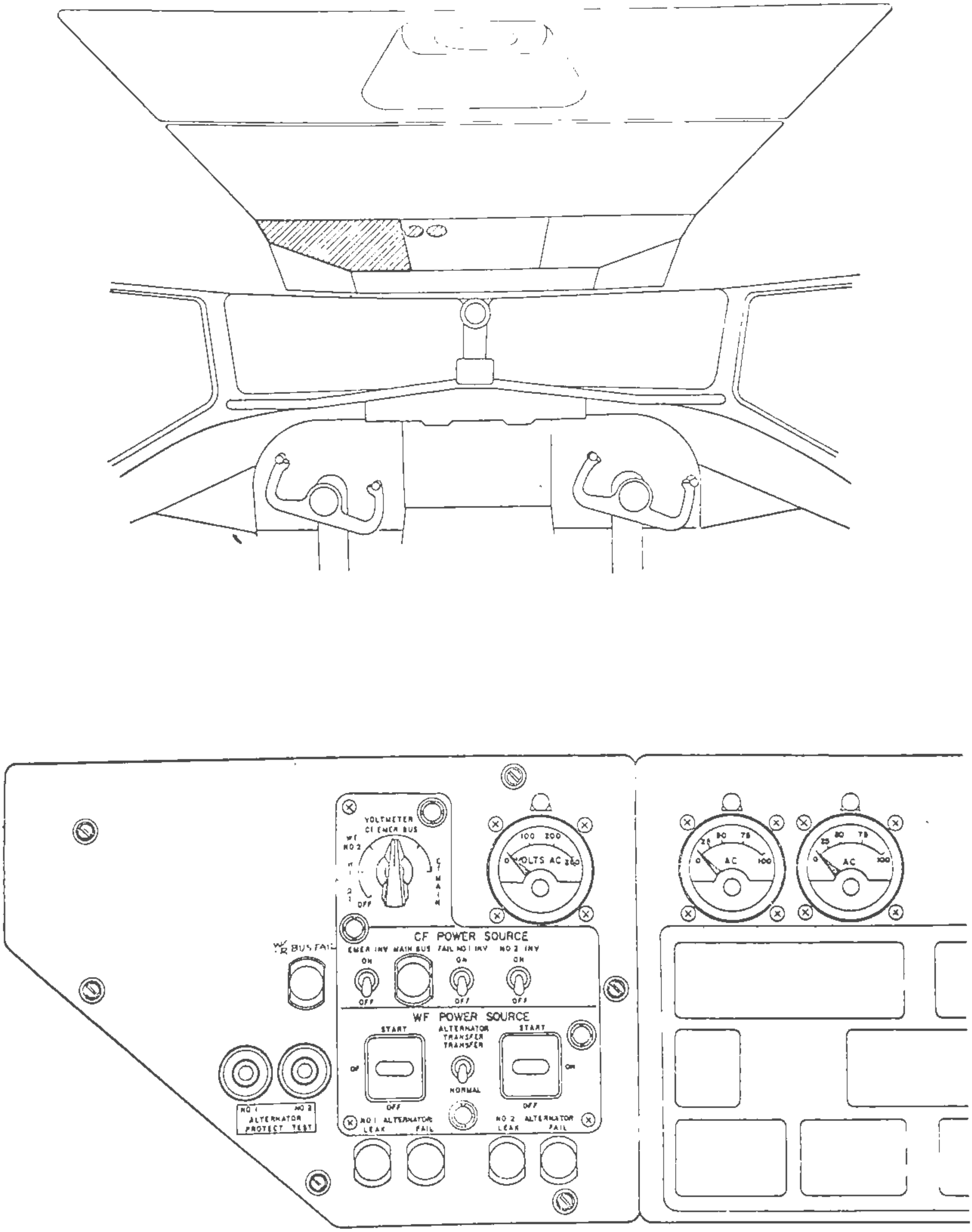
If the earth leak of the feeder reaches approximately 10 mA, the leak light comes on.

(5) Low Voltage Indication

If the alternator terminal voltage reaches 174 ± 5V or 130 ± 5V in case of 204V or 150V operation, respectively, the earth leak light comes on.

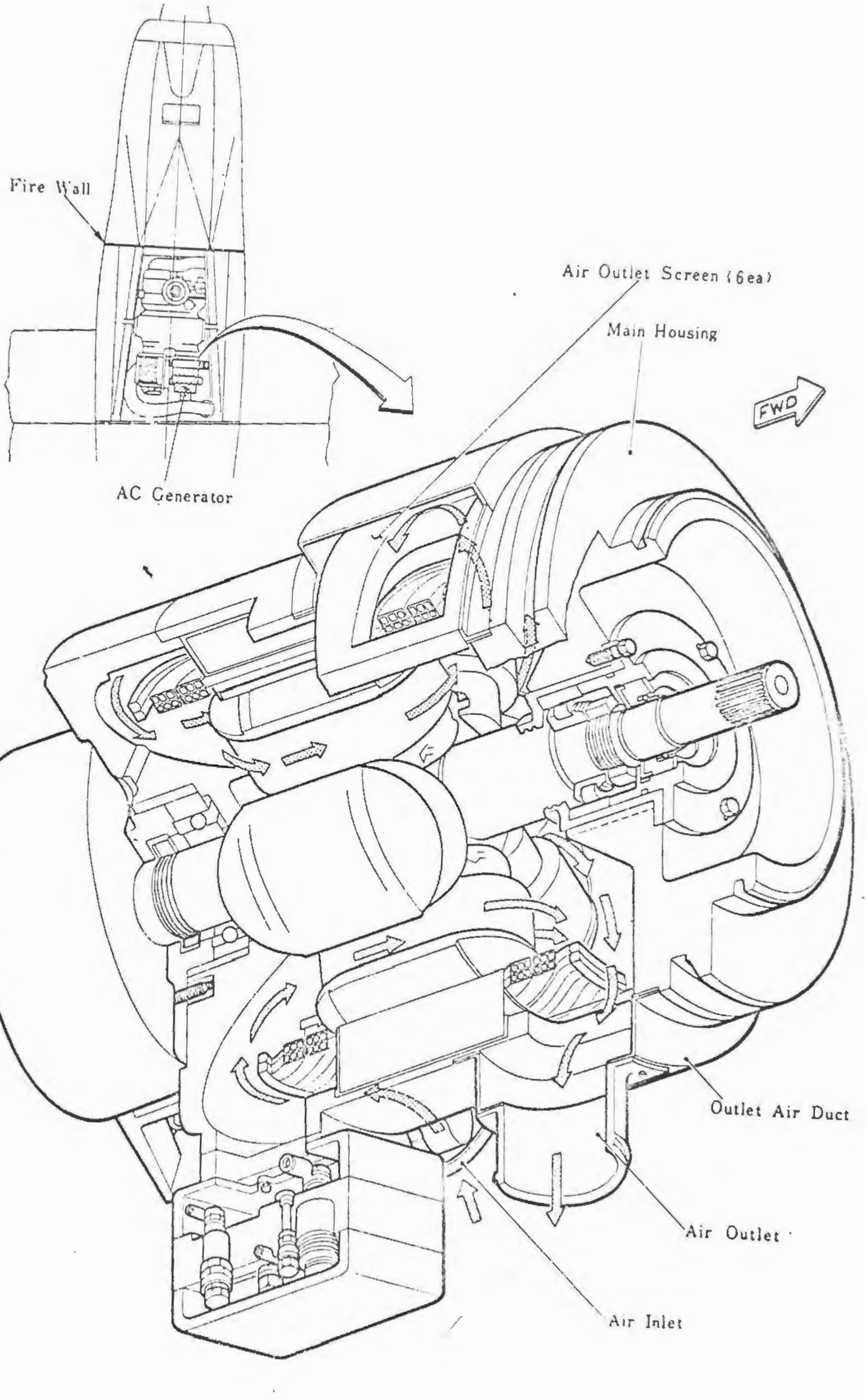
9.4.5 WF Distribution

No. 1 alternator normally supplies power to No. 1 engine and propeller deicers, foot warmer and windshield. No. 2 alternator supplies power to No. 2 engine and propeller deicers, galley and windshield. If either one of them fails, power can be cross-fed by setting the transfer switch to "TRANSFER." However, No. 1 alternator can not supply power to the galley.

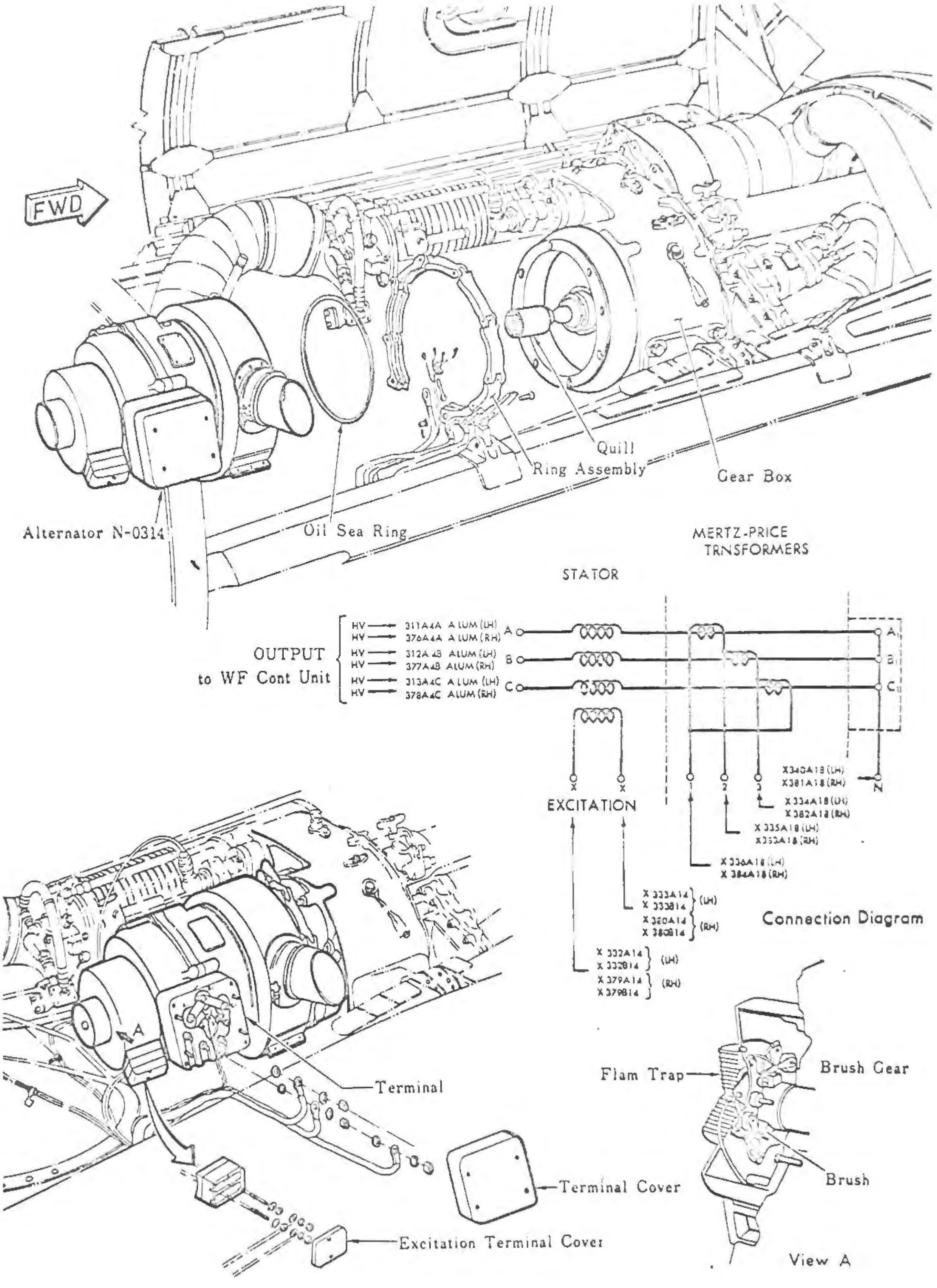


AC Control Panel

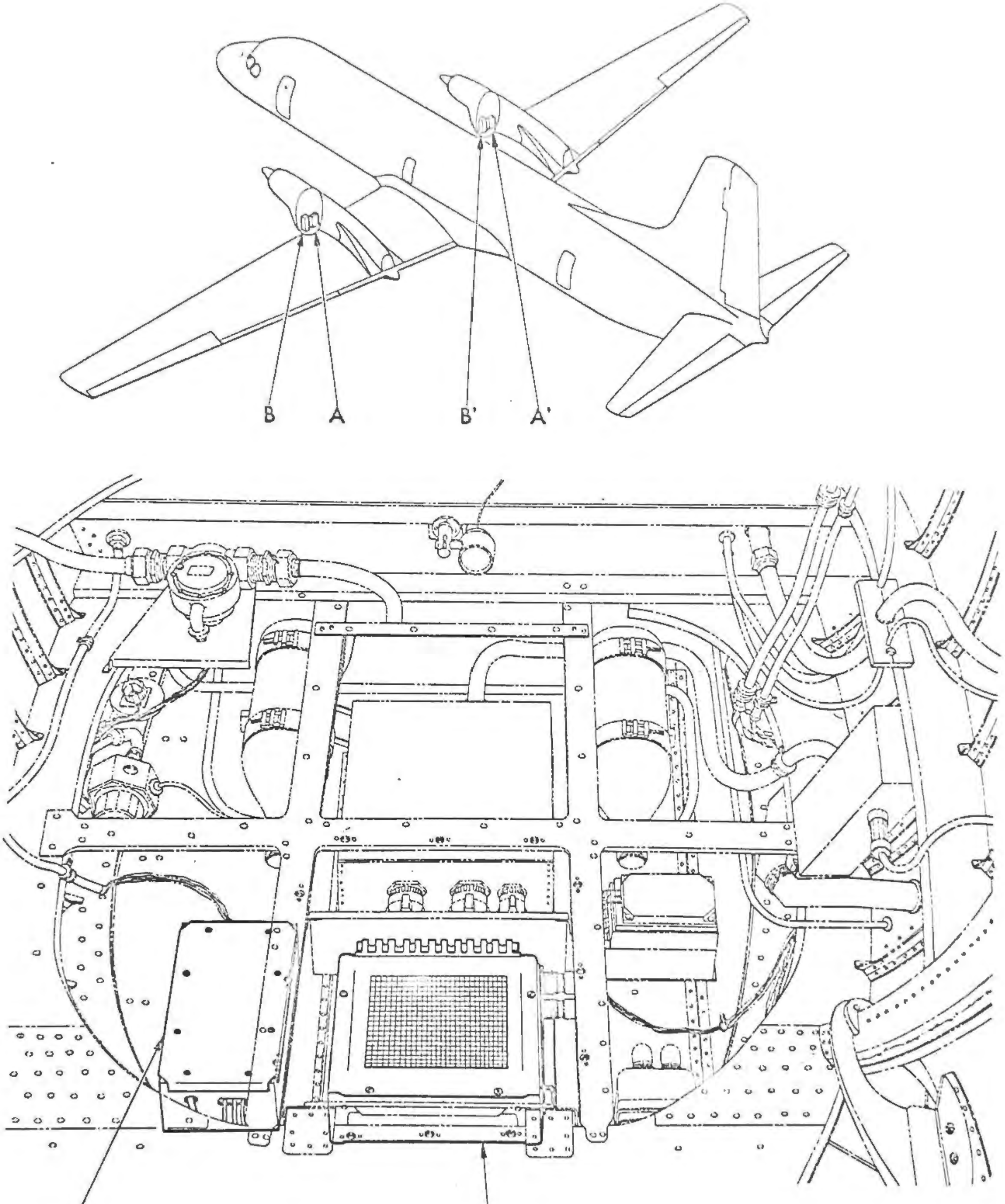
Figure 9-19



Alternator Cooling
Figure 9-20



WF Alternator Installation
Figure 9–21



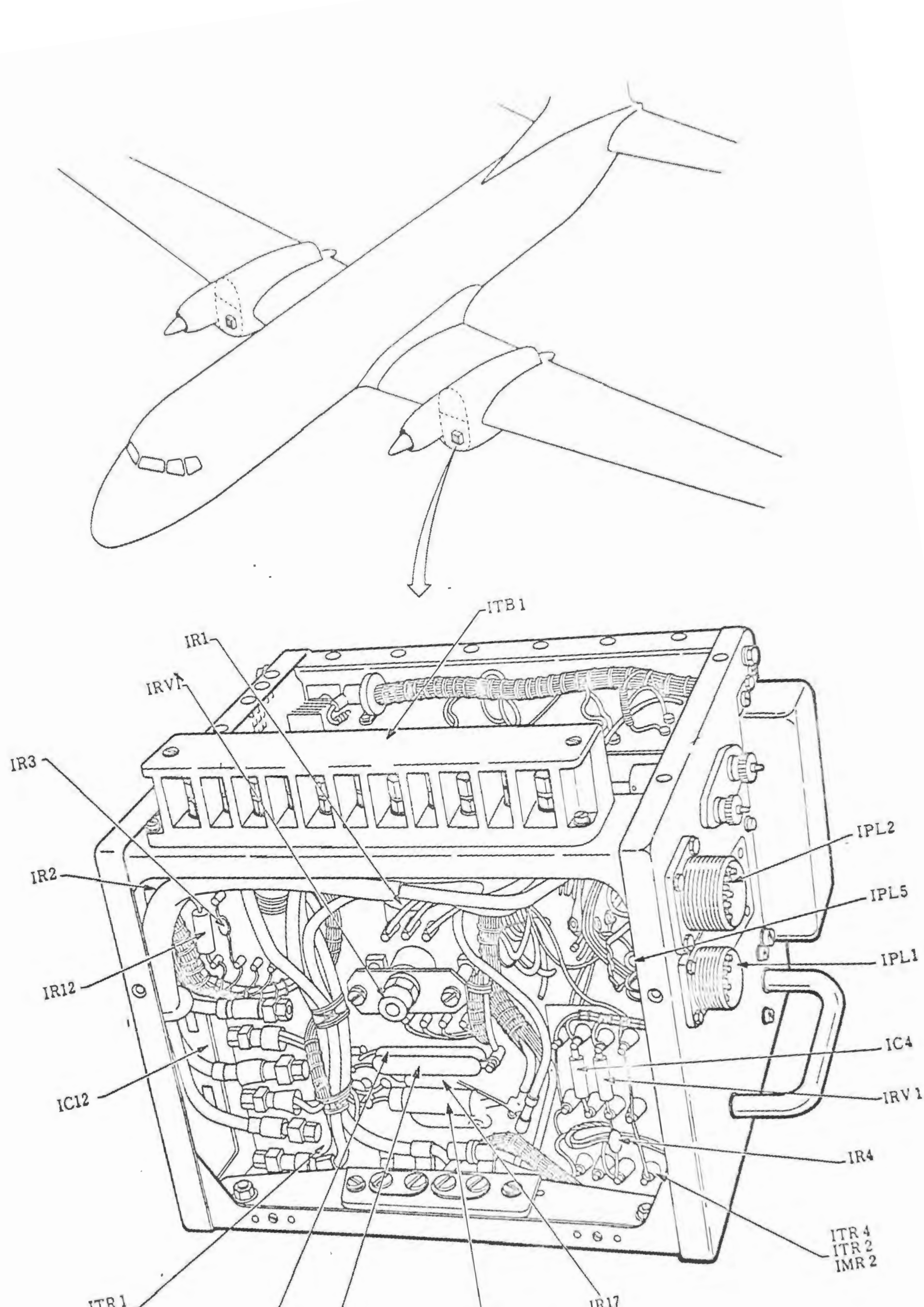
B No.1 Engine WF Power Junction Box

A No.1 Engine WF AC Control Unit

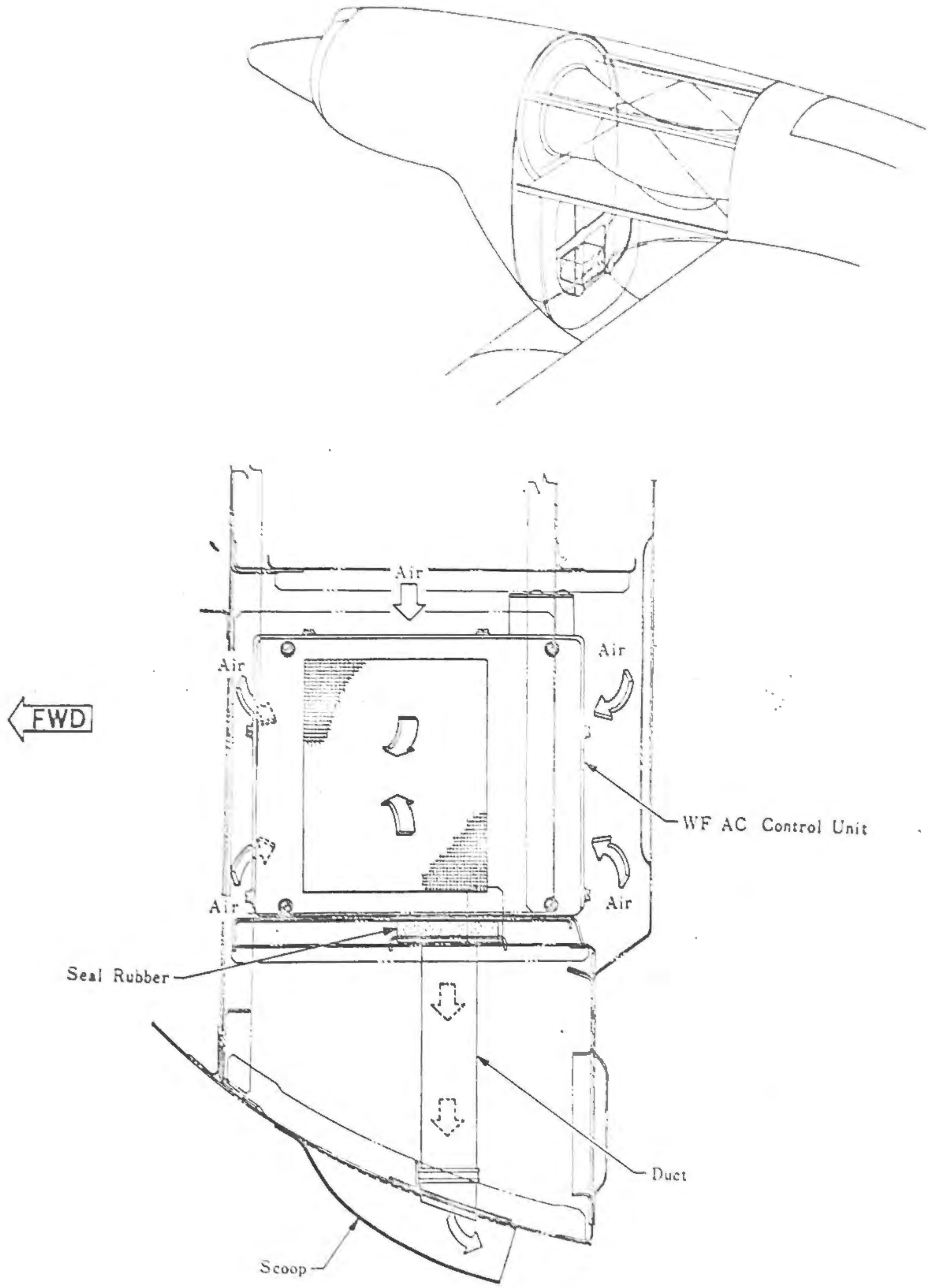
A' No.2 Engine WF AC Control Unit

B' No.2 Engine WF Power Junction Box

WF AC Control Unit, WF Power Junction Box
Figure 9–22

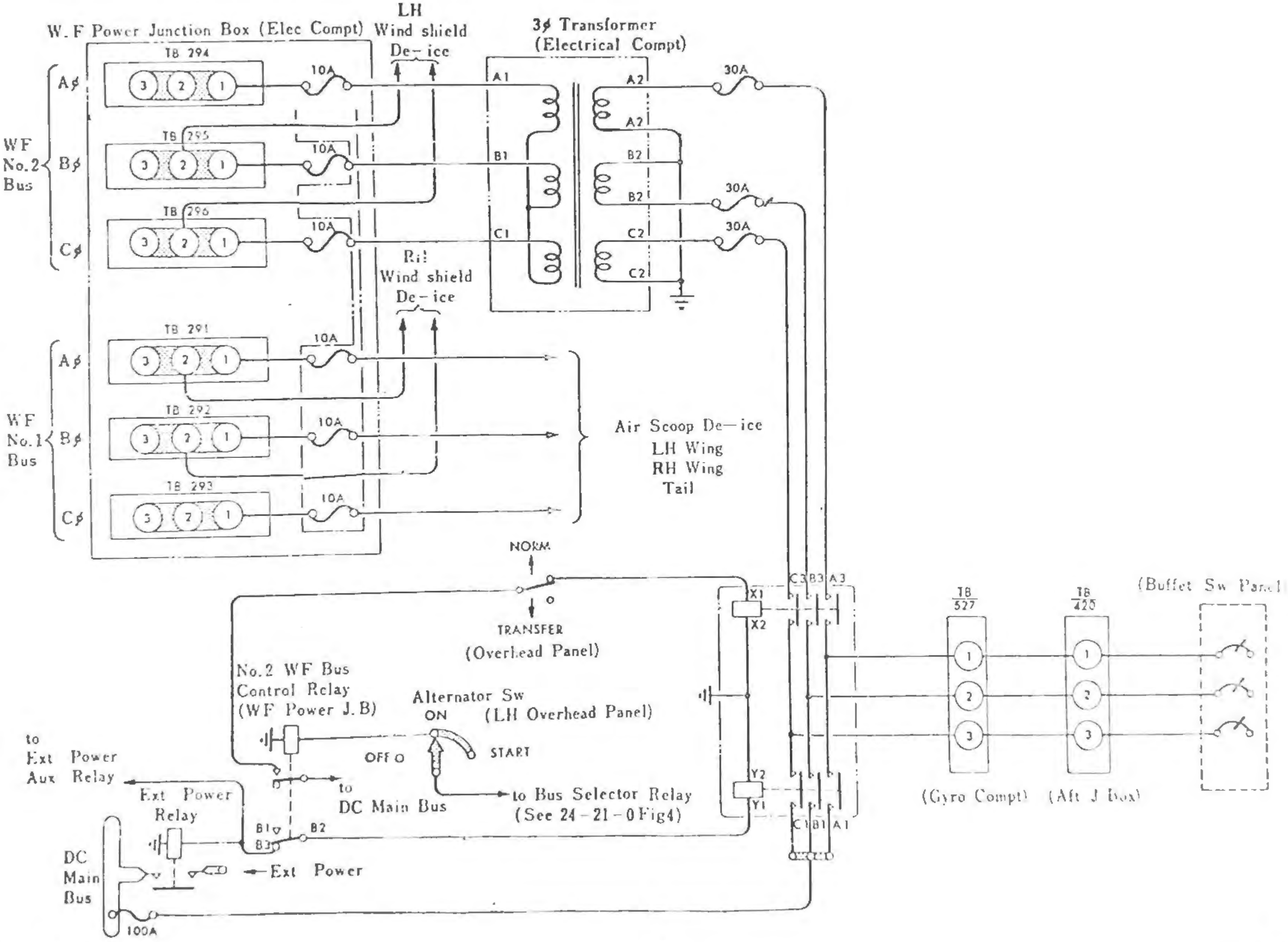


Alternator Control Unito
Figure 9–23

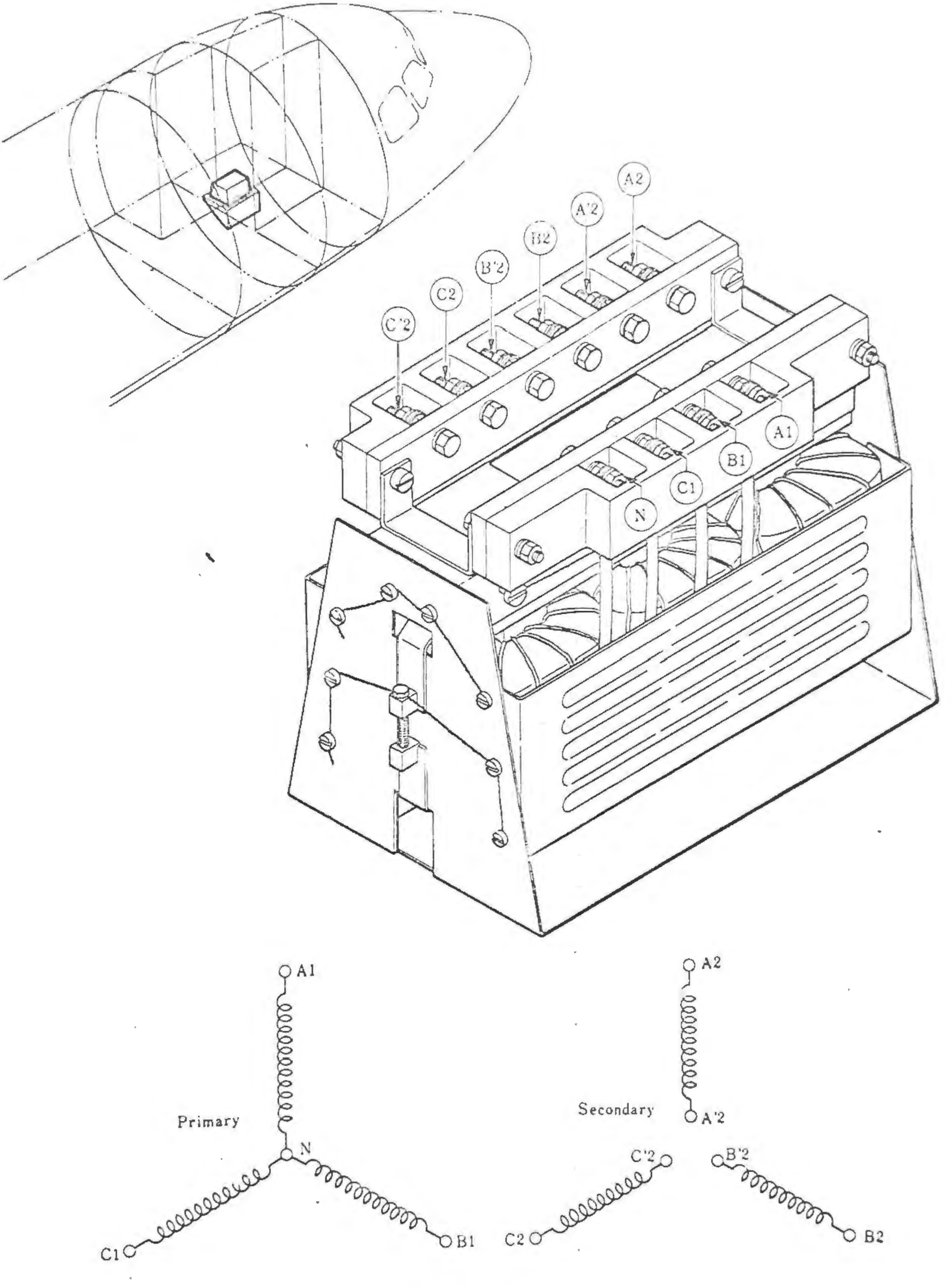


Alternator Control Unit Cooling

Figure 9-24



WF Power Distribution Schematic Diagram
Figure-9-26.



F3 Phere Transformer
Figure 9–27

9.4.6 3 Phase Transformer

Power supply to the galley is carried out by a 3 phase transformer located in the electrical compartment. Its capacity is 3KVA with the primary voltage of 204V and the secondary voltage of 28V. The transformer can be used with the ground power unit by means of a selector relay.

9.5 Installation of Electrical Equipment

9.5.1 Main Junction Box

Most of the electrical equipment are installed on a panel provided in the main junction box and they are grouped systematically to facilitate maintenance. In addition, the fuse panel, forward circuit breaker panel and aisle side circuit breaker panel are provided. A panel which contains the spare fuses and lamps is also provided.

9.5.2 Circuit Protecting Devices

(1) Current Limiter

To protect the electrical circuits of each system against heavy current, current limiters are used. They are provided in the battery circuit, feather circuit, inverter circuit and hydraulic pump circuit.

(2) Circuit Breaker

To protect the electrical circuits against medium current, push pull circuit breakers are used. Some circuit breakers of toggle type are also used for this purpose.

(3) Fuse

To protect the electrical circuits against low current, fuses are used. When a fuse is burnt out, a neon lamp in the holder comes on. White neon lamps are used for DC 28V and AC 26V systems. Amber ones are used for AC 400 c/s, 115V systems.

9.5.3 Symbols used in Wiring Diagrams

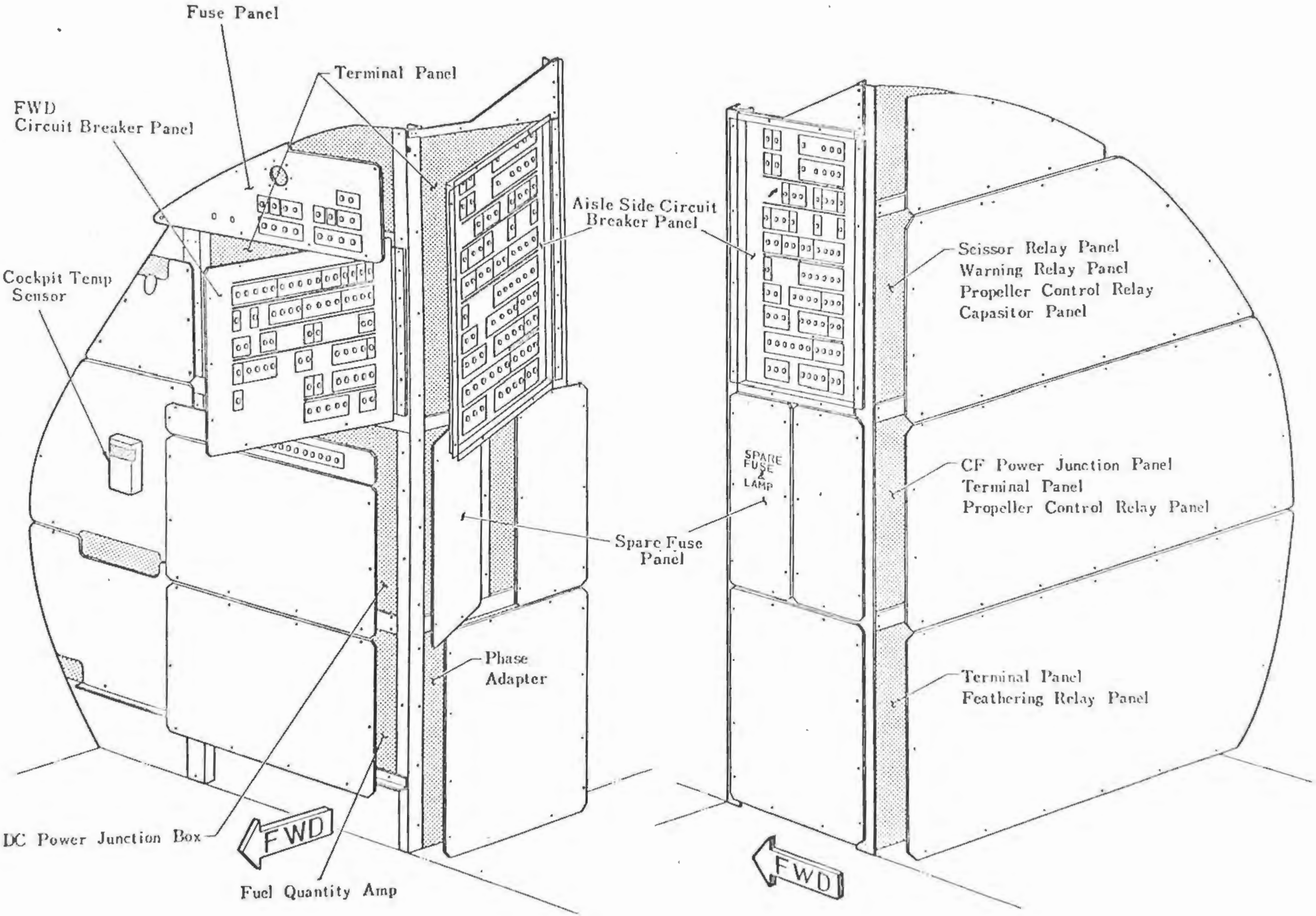
The wiring diagrams have been prepared for each system of the aircraft.

(1) to illustrate the functions,
(2) to facilitate maintenance, and
(3) to facilitate checking.

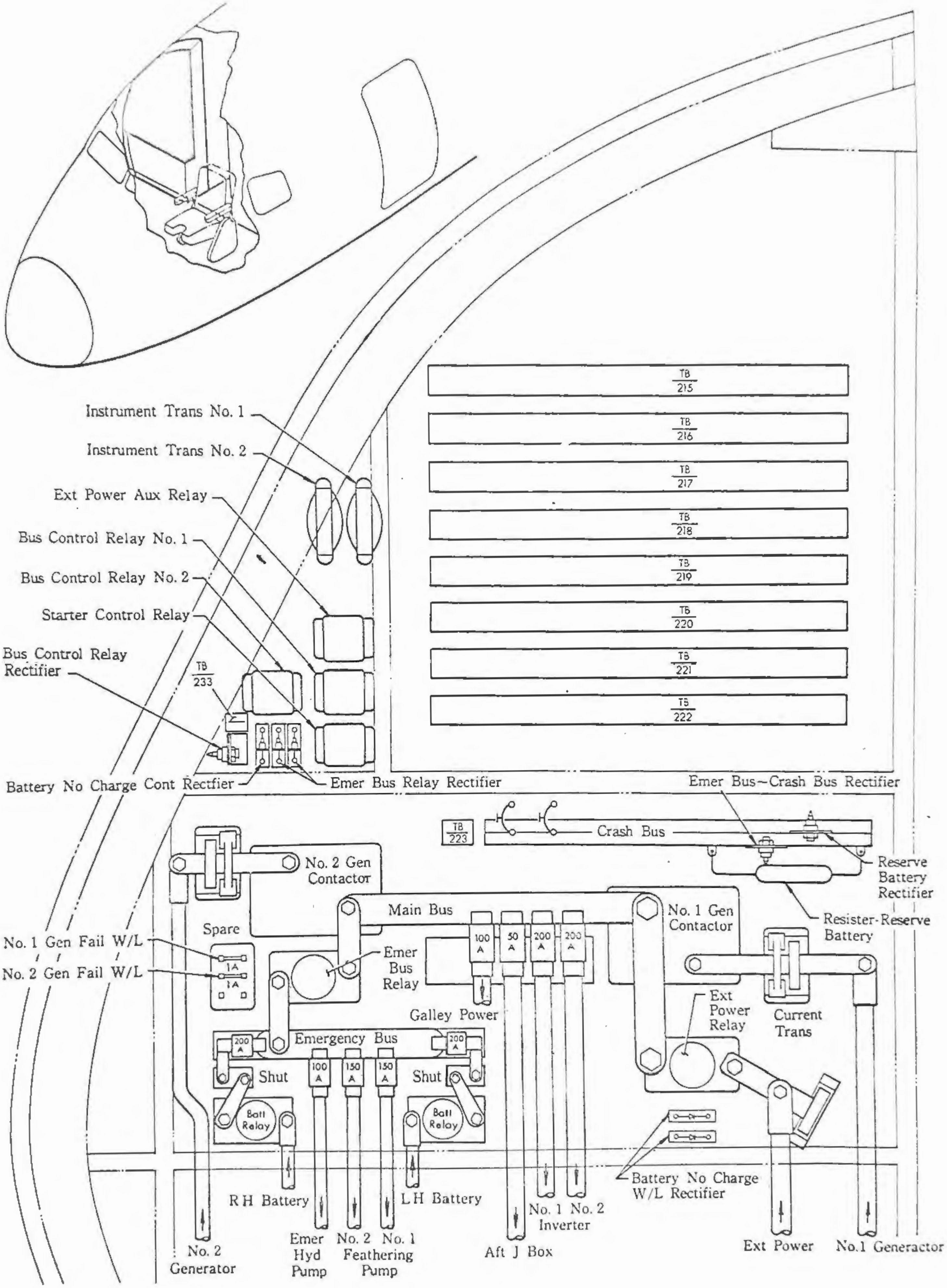
Components used in the wiring diagrams are shown in symbols for the sake of simplicity.

9.5.4 Load Analysis

The status of AC and DC power under various aircraft conditions has been analyzed in accordance with MIL-E-7610A and MIL-E-7017.



Main Junction Box
Figure 9-28



DC Main Junction Box
Figure 9–29

9.5.5 Wiring

The following wires are used for the aircraft wiring:

(1)	MIL-W-5086A	Copper wire
(2)	MIL-W-7072A	Aluminum wire
(3)	MIL-W-7078	Shielded wire
(4)	MIL-W-7139	Heat resistant wire
(5)	MIL-C-25038	Heat resistant wire

Conduits are used for the wiring of the landing gear and the landing gear bay to prevent wires from exposing.

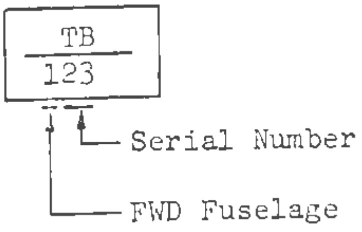
Bonding is carried out in the aircraft to maintain electrical stability of the aircraft, to avoid lightning, static discharge and radio noise and to establish the return line of current.

Quick disconnect terminals are used in the wiring of each panel in the cockpit to facilitate removal and installation.

9.5.6 Terminal Board

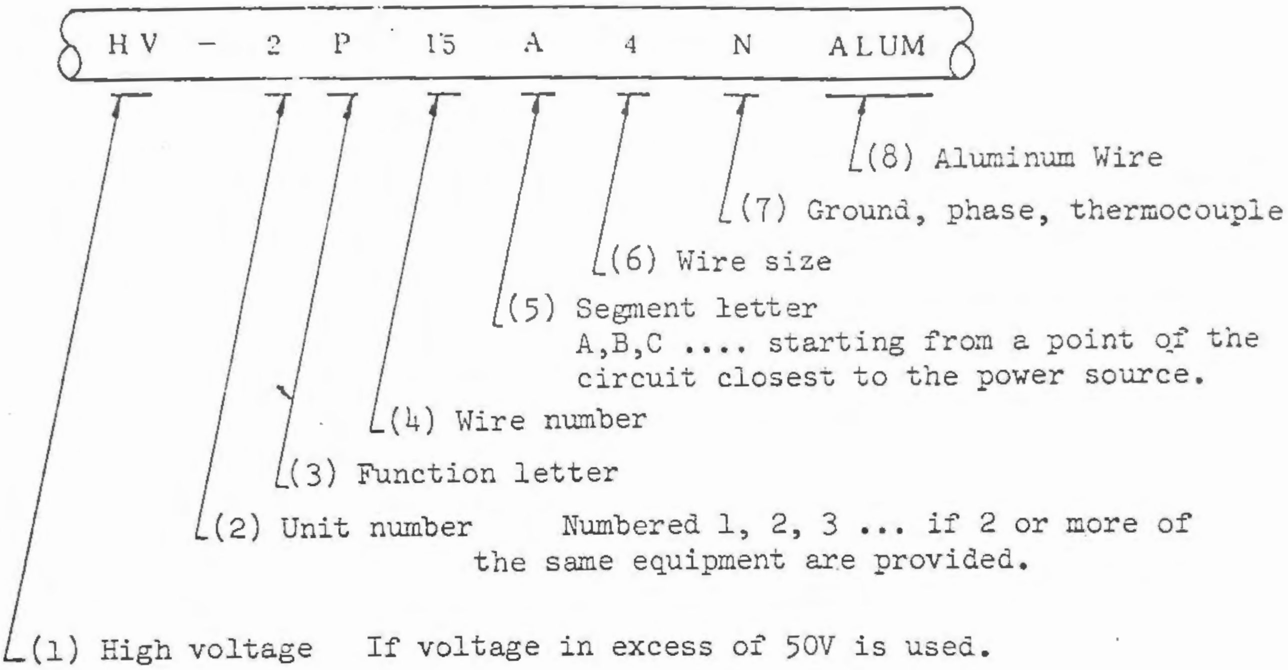
Terminal boards are provided at important points to facilitate airframe wiring check. A name plate with TB number stamped is fitted adjacent to the terminal board for the identification of the terminal board. A TB number consists of three digits. The first digit represents each compartment, while the second and third digits are serial numbers assigned from forward to rear and from top to bottom. Serial numbers are provided on the outer wing except the nacelle, starting from the wing station 0.

No.	Location
1 x x	FWD Fuselage
2 x x	M/J/B, Electric Compartment
3 x x	Radio Rack
4 x x	Cabin
5 x x	Belly Cargo, Gyro, Leading Edge
6 x x	Hyd, Aircon Compartment
7 x x	Empennage
8 x x	L/H Outer Wing
9 x x	R/H Outer Wing



9.5.7 Identification Marking on Wires

The following marking is stamped on all the wires in the aircraft along the entire length at a certain interval. This marking consists of alphabetical letters and numbers. When a wire is used by 2 or more circuits, the marking applicable to the principal circuit is stamped on the wire.



(8) Aluminum Wire

(7) Ground, phase, thermocouple

(6) Wire size

(5) Segment letter
A,B,C .... starting from a point of the circuit closest to the power source.

(4) Wire number

(3) Function letter

(2) Unit number Numbered 1, 2, 3 ... if 2 or more of the same equipment are provided.

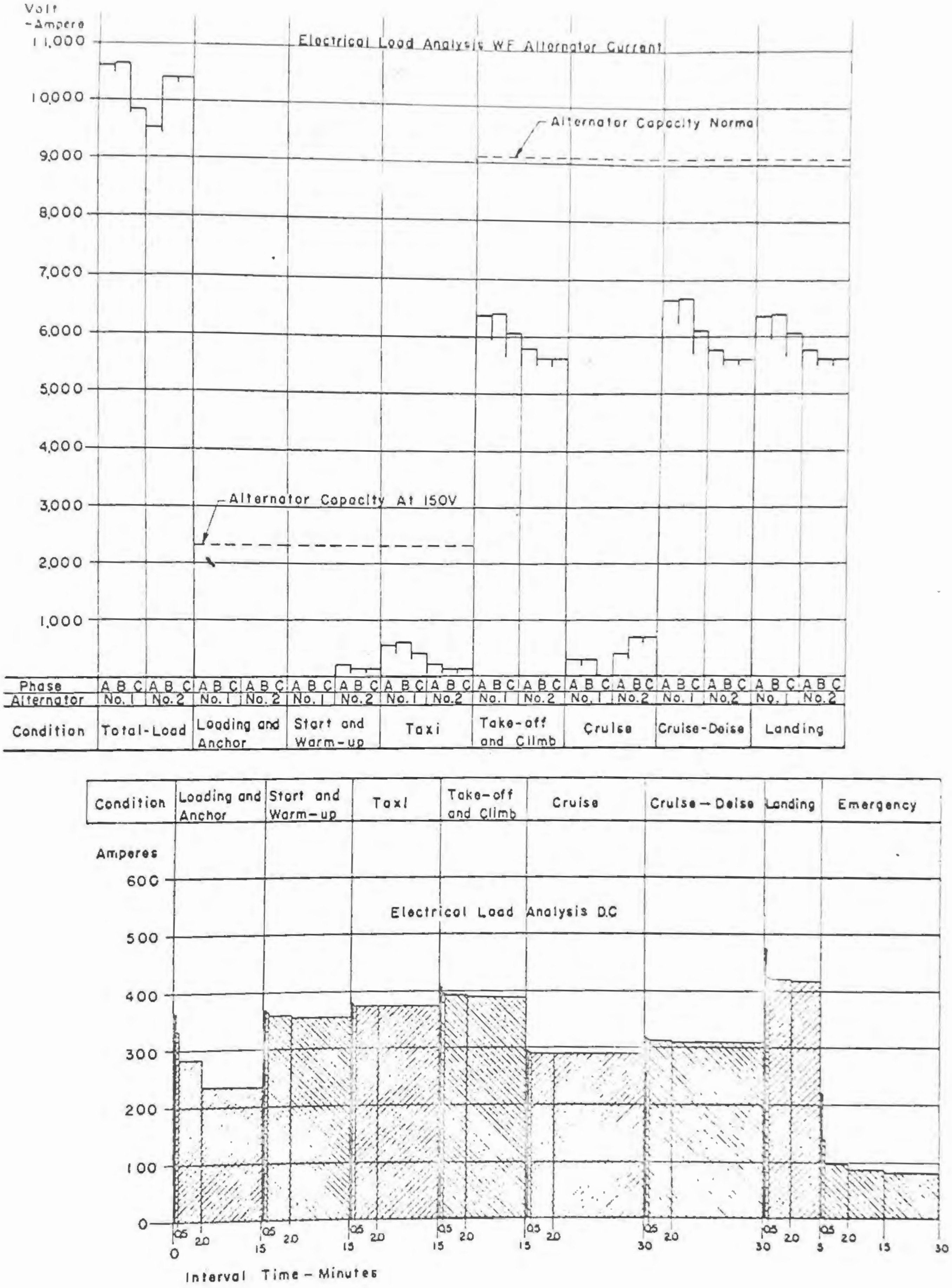
(1) High voltage If voltage in excess of 50V is used.

Function Letter

Letter	System
C	Flight Control
D	Instrument
E	Engine Instrument
F	Flight Instrument
G	Landing Gear
H	Heating, Ventilating, Deicing
K	Engine Control
L	Lighting
M	Miscellaneous
P	D.C. Power
Q	Fuel & Oil
R	Radio
W	Warning Devices
X	A.C. Power
RA	Glide Slope
RL	HF Communication
RM	Marker Beacon
RN	ADF, VOR
RR	VHF, Communication
RP	Radio Power
RZ	Interphone & Passenger Address
SS	Radar
TN	Navigation

Symbols for Grounding, Phase and Thermocouple

Letter	System
N	Ground
A.B.C.	Phase A, B, C
CHROM -ALL	Chromel - Alumel



Electrical Power Load Analysis
Figure 9–34

9.6 Lighting

Lighting in the YS-11 consists of interior lighting including cockpit and cabin lighting, exterior lighting including landing light, taxi light etc. and emergency lighting which illuminates the emergency exits.

9.6.1 Interior Lighting

(1) Cockpit Lighting

The cockpit lighting consists of lights for the main instrument panel, engine instrument panel, L.H. and R.H. side panels, overhead panel, auxiliary panel and pedestal and reading lights. Brightness of these lights can be adjusted independently by the adjusting resistors located on the over-head panel.

(2) Cabin Lighting

The cabin lighting includes lights for the entrance, cabin, galley, toilet and placards which are turned on or off by the switches installed on the forward and aft stewardess panel.

(3) Cargo Compartment and Maintenance Compartment Lighting.

(4) Landing Gear Compartment Inspection Lights and Down Lock Inspection Lights.

(5) Emergency Lighting

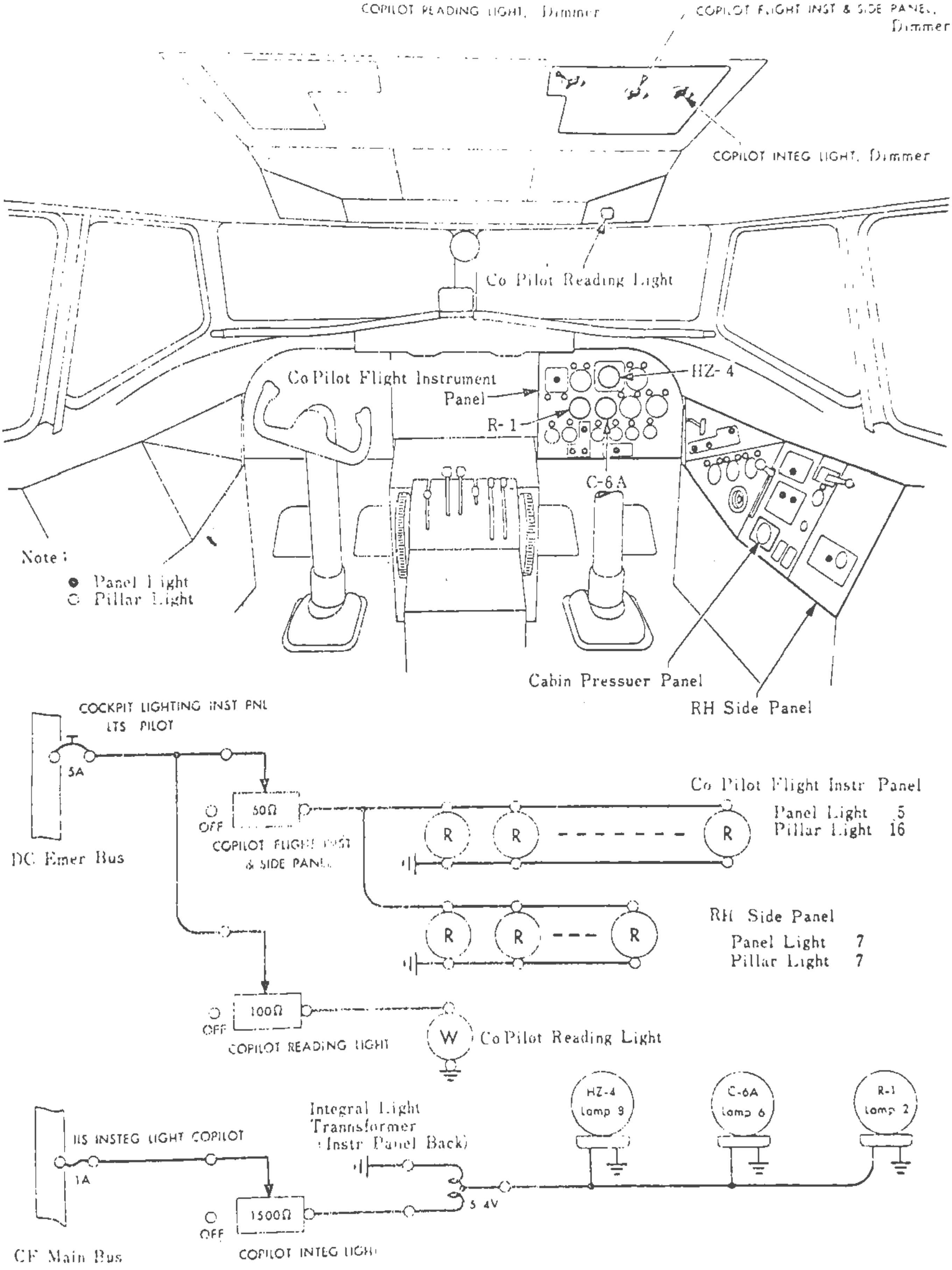
Inertia flash lights and portable water-proof lights are provided for emergency lighting. If forward acceleration is applied to the aircraft at the time of emergency landing or ditching, the inertia flash lights come on. They are located above the L.H. and R.H. emergency exits, aft cargo door and aft service door. A portable water-proof light is also provided on the bulkhead behind the pilot.

9.6.2 Exterior Lighting

The exterior lighting consists of two landing lights, one taxi light, three navigation lights, two anti-collision lights and two ice inspection lights.

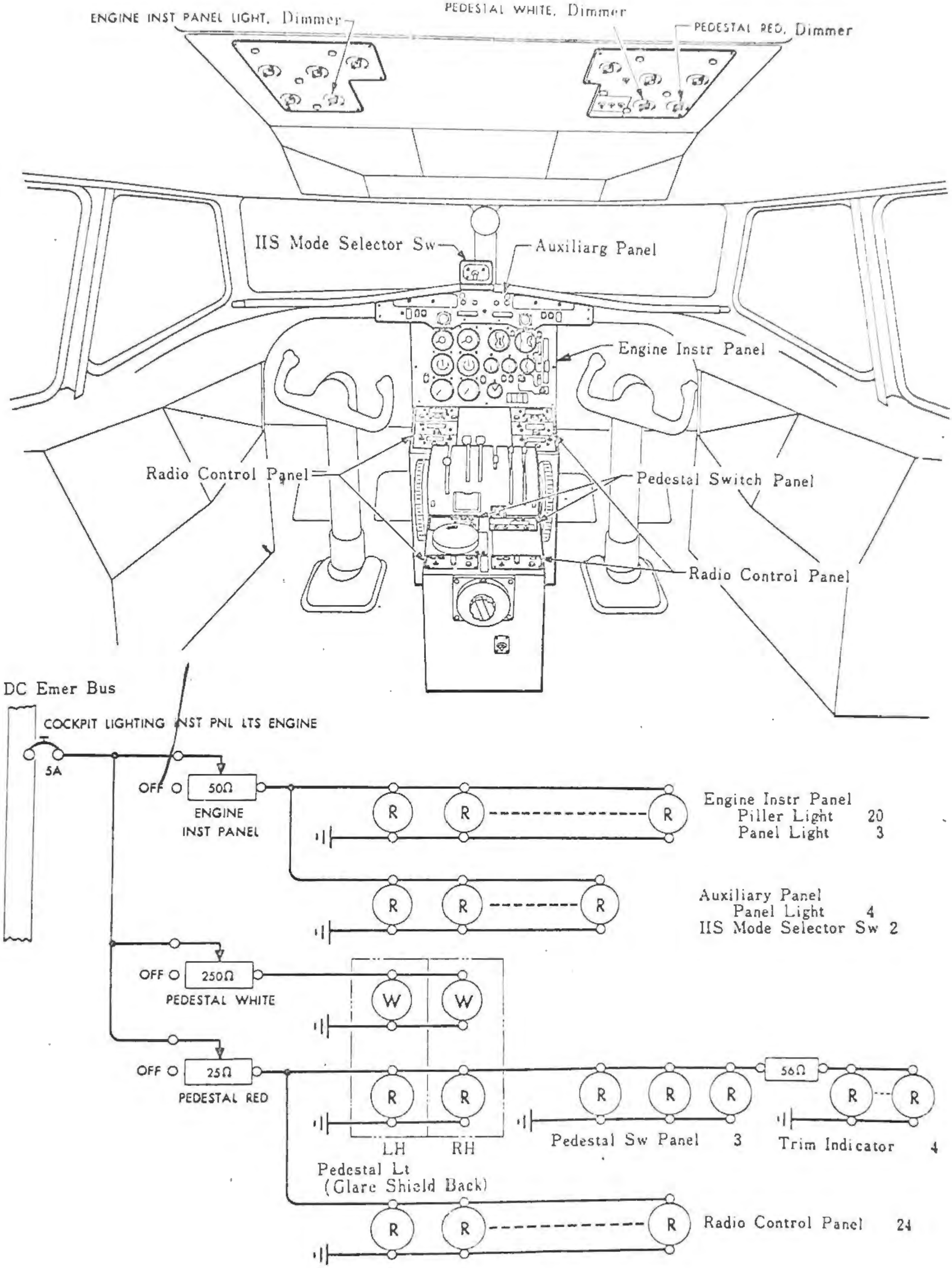
(1) Landing Light

On the lower surface of the L.H. and R.H. wing are provided the landing lights which can be retracted electrically. A 600 W lamp is contained inside and the light can be extended or extracted by a motor. The light is set at 88° ± 1°.
If the light is lowered even a little, the indicator light comes on.
Do not turn on the landing light on the ground for more than 30 sec.

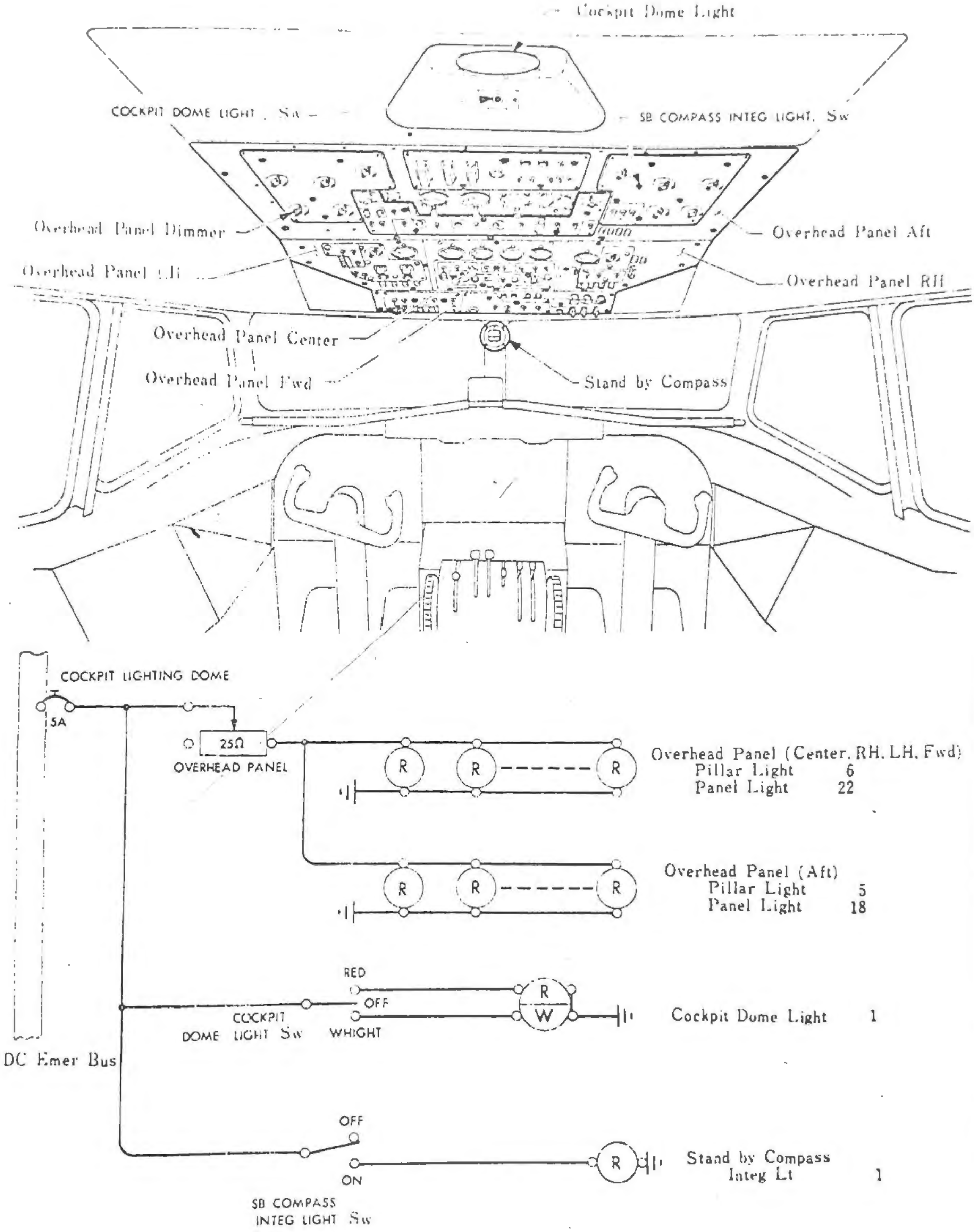


Copilot's Side Light System

Figure 9-36



Center Section Lighitng System
Figure 9–37



Upper Section Lighting System

Figure 9–38

(4) Brush Sealing

Brush sealing is accomplished by applying sealant on the bolt heads, rivet heads and the faying surfaces of small sheets with a brush.

Compound to be used: PR-1422 Class A-2

(5) Top Coating

Top coating is employed to finish tank sealing with the final protective coating after having applied sealing method (1) through (4) described above.

Compound to be used: PR-1005L Types I and II

(6) Anti-bacteria Coating (Fig. 5-3A)

Anti-bacteria coating is provided on the top coating (PR-1005L) of a part of the integral tank. For its extent, see Fig. 5-3A.

Coating material to be used: DV-1180

The bottom of the filler pan is provided with a pipe fitting for letting overflow fuel during refueling drop below the lower wing surface.

The cap installed on the neck is guaranteed to be air tight against 25 psi from inside the tank and 3 psi from outside the tank.

The cap can be locked or unlocked by rotating it approximately 45°. The marking in the round opening in the surface of the cap consists of the following:

Yellow in UNLOCK position
Red in between
Green in LOCKED position

B. Pressure Relief Valve (See Fig. 5-5)

This valve is provided with a simple mushroom shaped spring. When the internal pressure is applied to the top of the valve, the valve is brought down against the spring force, producing a gap between the valve and the valve seat, through which fuel can flow through the large cylindrical mounting pipe and is directly discharged to the ground below the lower wing surface.

The cracking pressure of the valve is 1.5 psi. It requires a pressure gradient of 2.3 psi at a flow rate of 200 U.S. gal/min.

C. Vent Float Valve (See Fig. 5-6)

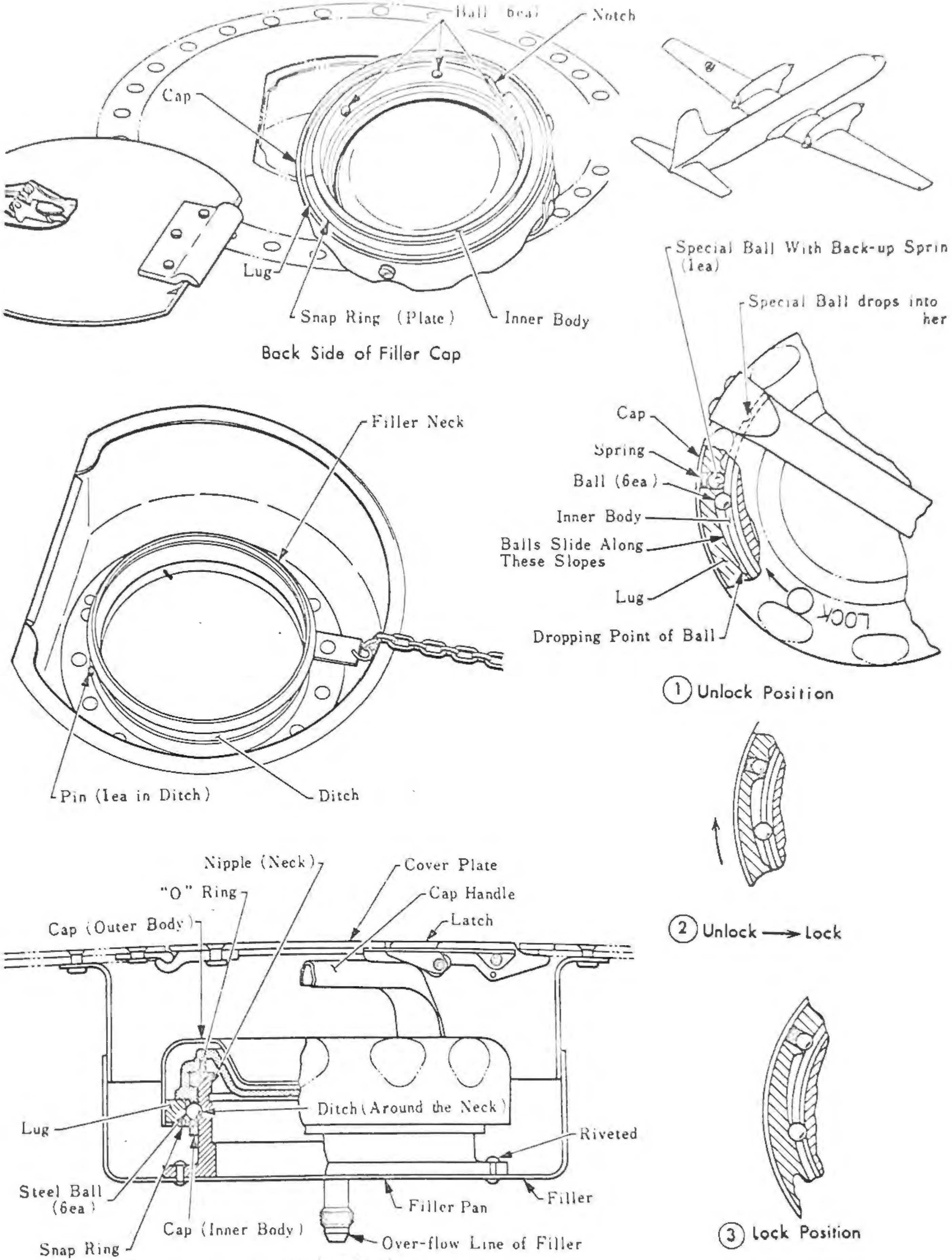
This valve is provided to accomplish the ventilation of the tank, prevention of fuel overflow, relief of tank internal pressure and alleviation of negative pressure in the tank.

Opening or closing of the flapper accomplish the above-mentioned function.

Ventilation: When the fuel level in the tank does not reach the float, the flapper is open to vent the tank.

Prevention of Fuel Overflow: When fuel in the tank rises above the level where the float kept afloat, the flapper is closed accordingly.

Alleviation of Negative Pressure: If fuel is consumed under the condition of closed flapper valve, the negative pressure inside the tank will be developed. At this point, the spring on the flapper is collapsed because the flapper is forced up by the external air pressure which passes through the suction port.



Back Side of Filler Cap

① Unlock Position

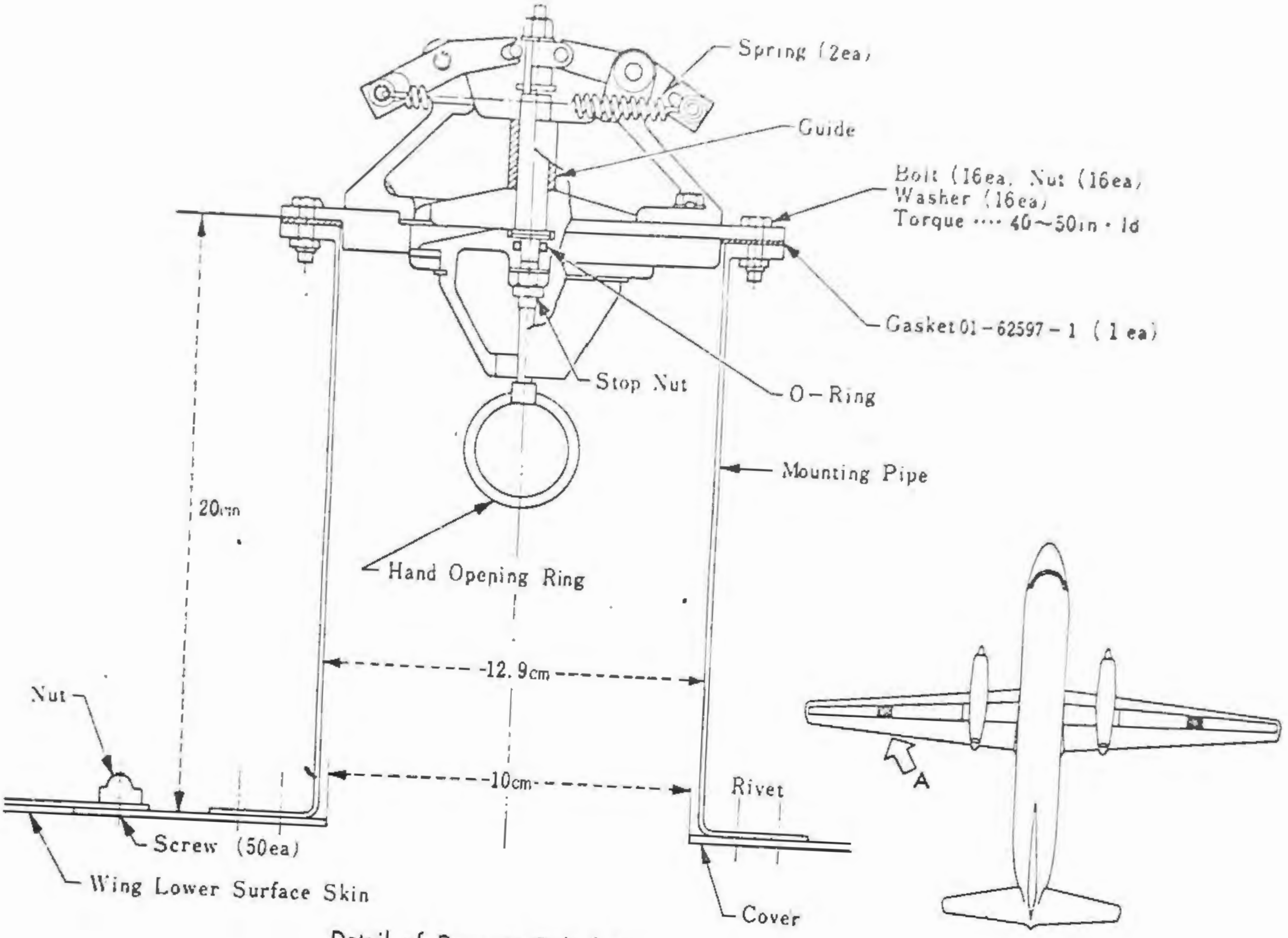
② Unlock ⟶ Lock

③ Lock Position

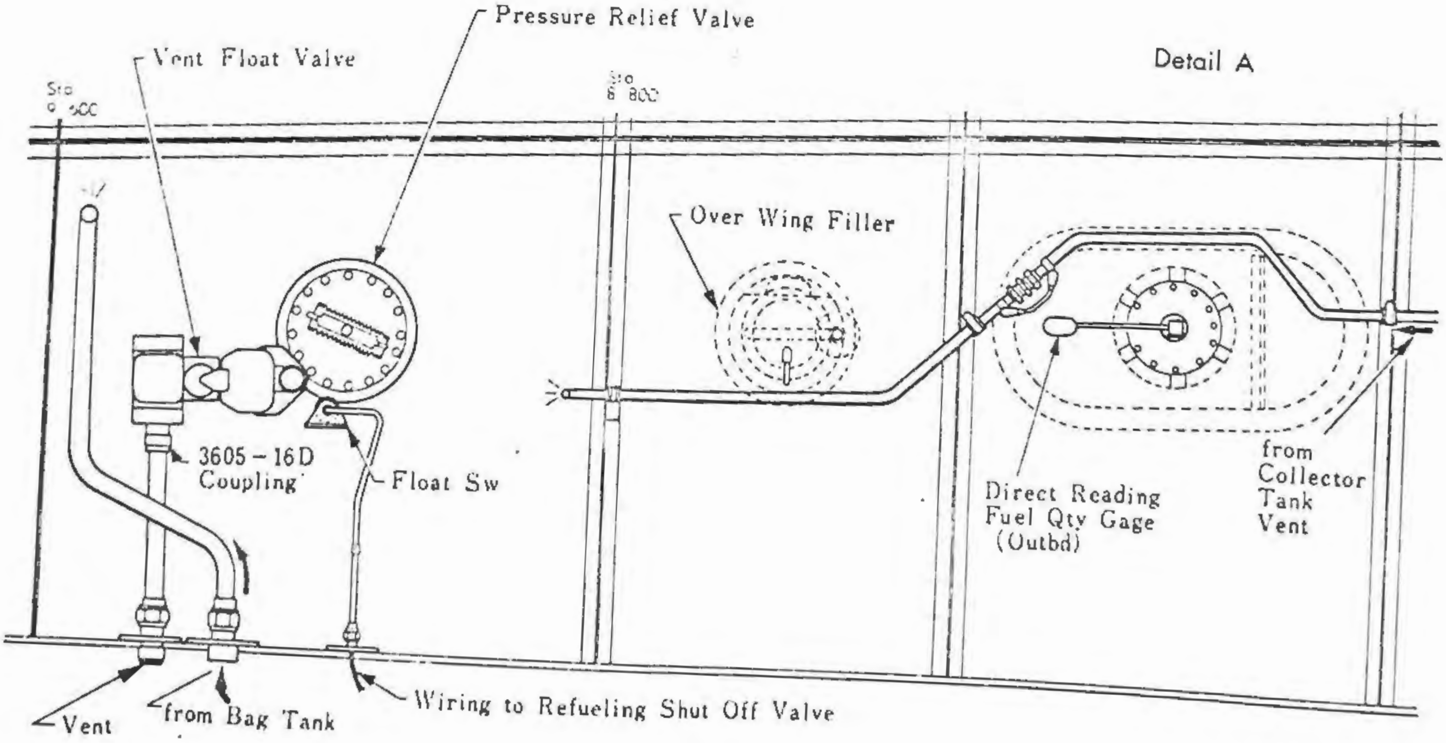
Cap Secured to Neck

Overwing Fuel Filler Cap

Figure 5–4



Detail of Pressure Relief Valve



Fuel Tank Pressure Relief Valve

Figure 5–5

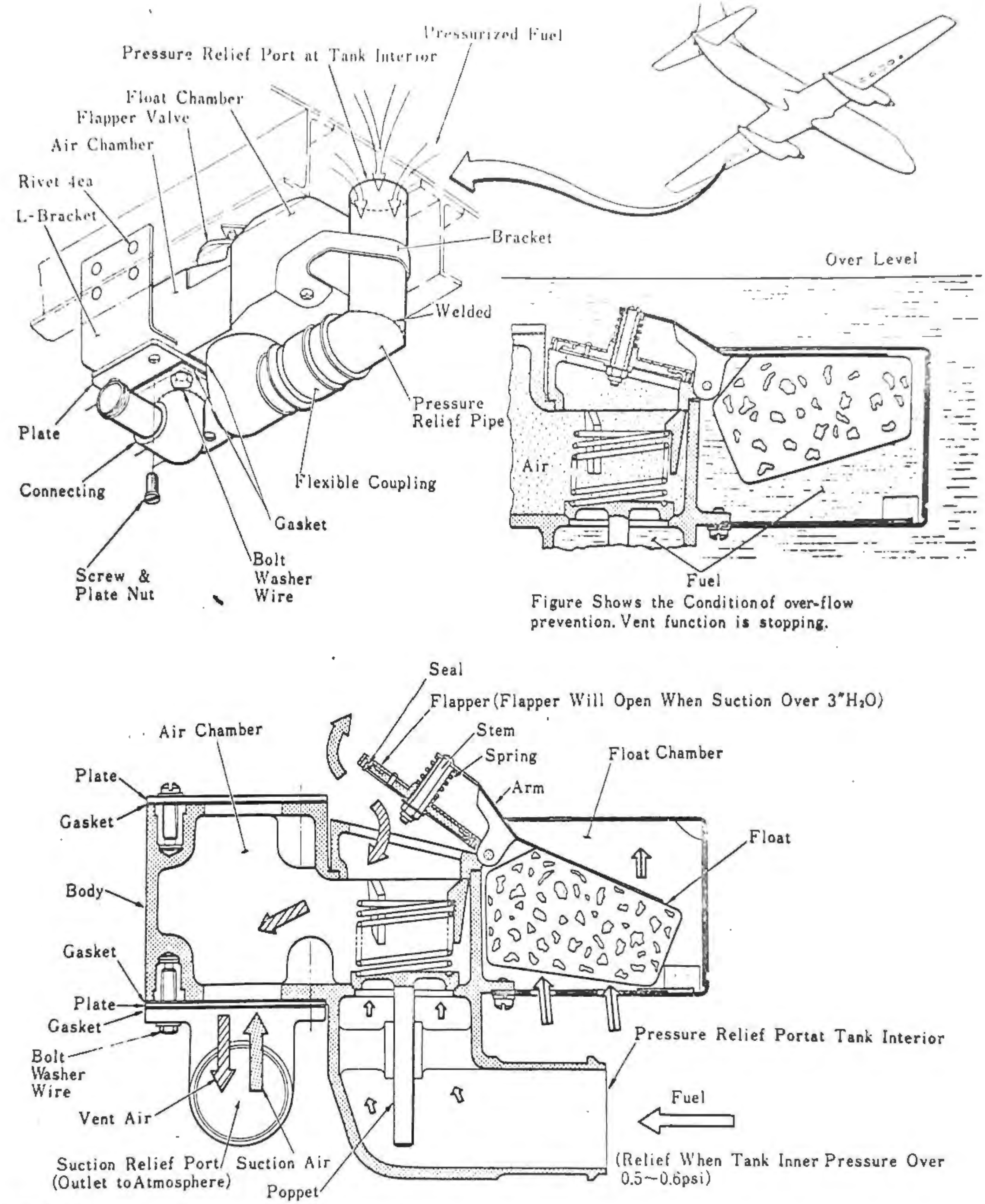
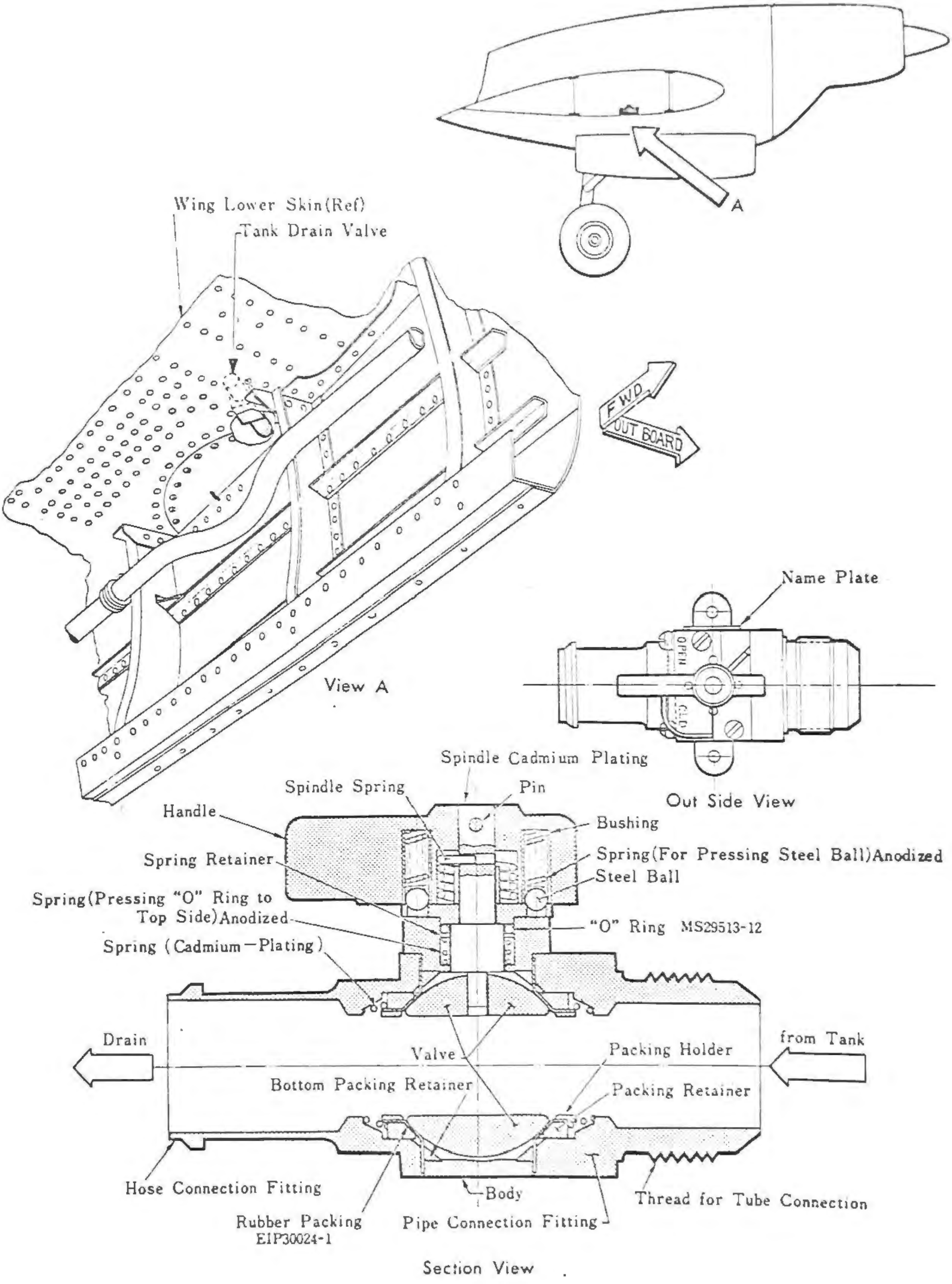


Figure Shows the Condition of over-flow prevention. Vent function is stopping.

REMARK :
▨ Tank internal air & Fuelgas mixture (escaping to Outside of Tank)
⇨ Outside Fresh Air (going into Tank interior)
⇨ Pressurized Fuel (relief to Outside passing through Relief Valve via Air Chamber)
⇒ Tank Fuel (only when fuel level over)

Fuel Vent Float Valve

Figure 5–6



View A

Out Side View

Section View

Fuel Tank Drain Valve
Figure 5-7

Relief of Internal Pressure of the Tank: As the internal pressure of the tank grows higher, the fuel or gas climbs up from below and opens the poppet of the pressure relief port which is normally kept in the closed position by the spring to relieve the internal pressure (opening pressure is 0.5 psi).

D. Drain Valve (See Fig. 5-7)

It is a manually-operated, 1 inch size, two way valve. The valve has a flow path which is opened or closed by the 90° switchover of the handle.

5.3 Fuel Refueling System

5.3.1 Gravity Refueling

Filler cap is provided on the upper surface of the wing at each tank location as supplementary refueling means.

Gravity Refueling Amount is as follows:

No. 1 Tank 2,520ℓ (about 666 U.S. gal.)
No. 4 Tank 2,520ℓ (about 666 U.S. gal.)

NOTE: Regarding construction and operation of Filler Cap, see "Chapter 5.2 Fuel Tank."

5.3.2 Pressure Refueling (See Fig. 5-8)

The purpose of the pressure refueling is to shorten the refueling time.

Refueling ports are located near W STA 0 of L.H. side. The refueling piping is routed on the back side of the wing rear spar, entering the tank at W STA 5500. At the tank inlet, a screen assembly is installed to disperse the incoming fuel.

Pressure Refueling Amount is as follows:

No. 1 Tank	2,495ℓ	(about 659 U.S. Gal.)	50 psi	200 U.S. Gal./min.
No. 2 Tank	2,495ℓ	(about 659 U.S. Gal.)	50 psi	200 U.S. Gal./min.

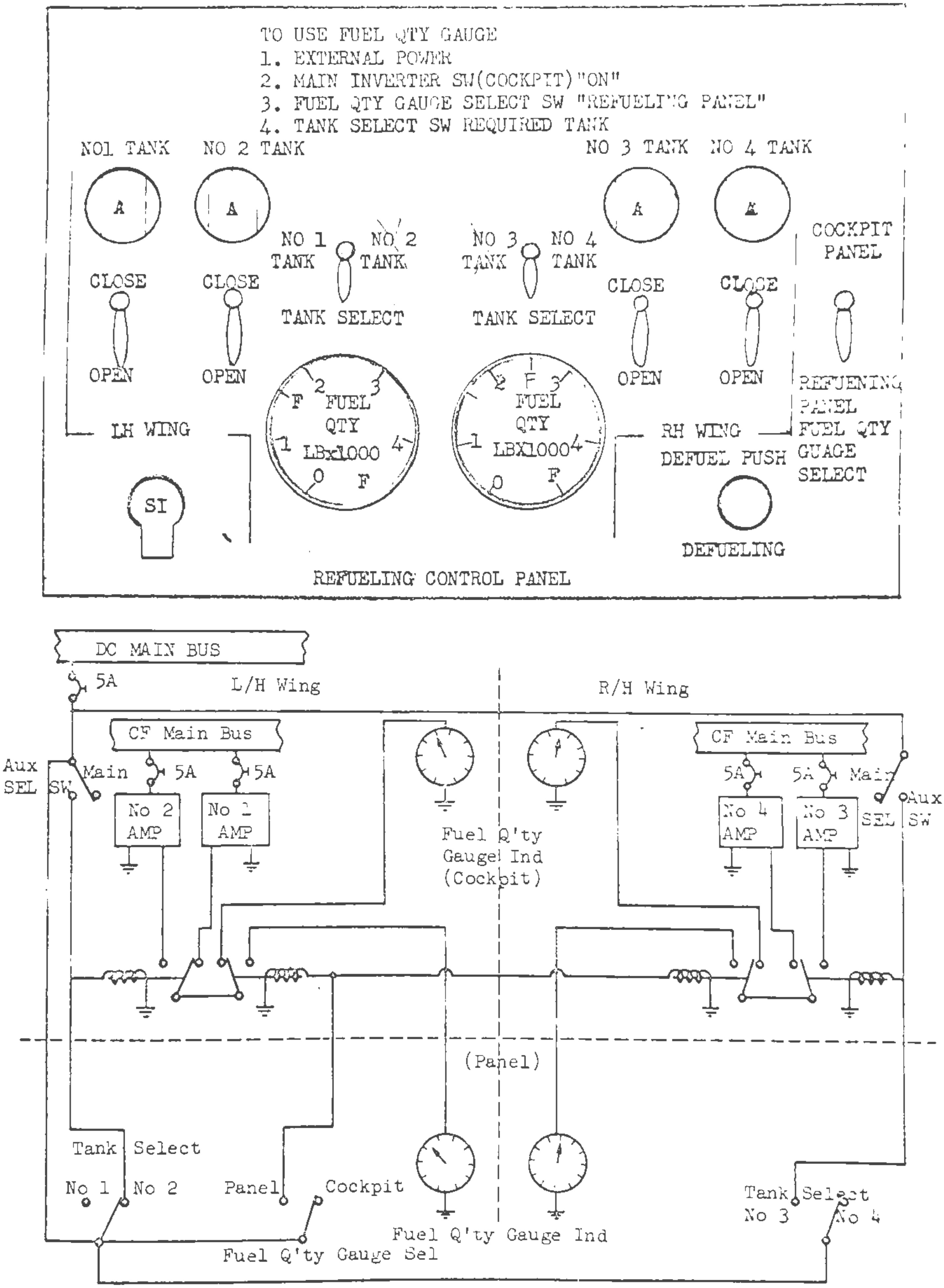
5.3.3 Construction of Pressure Refueling System (Fig. 5-8A, 5-8B)

Refueling system components and locations are as follows.

(1) Control panel	W STA 0
(2) Shut-off valve	In refueling line
(3) Float switch	Inside tank
(4) Circuit Breaker	Outboard side of nacelle (Only Left Nacelle)

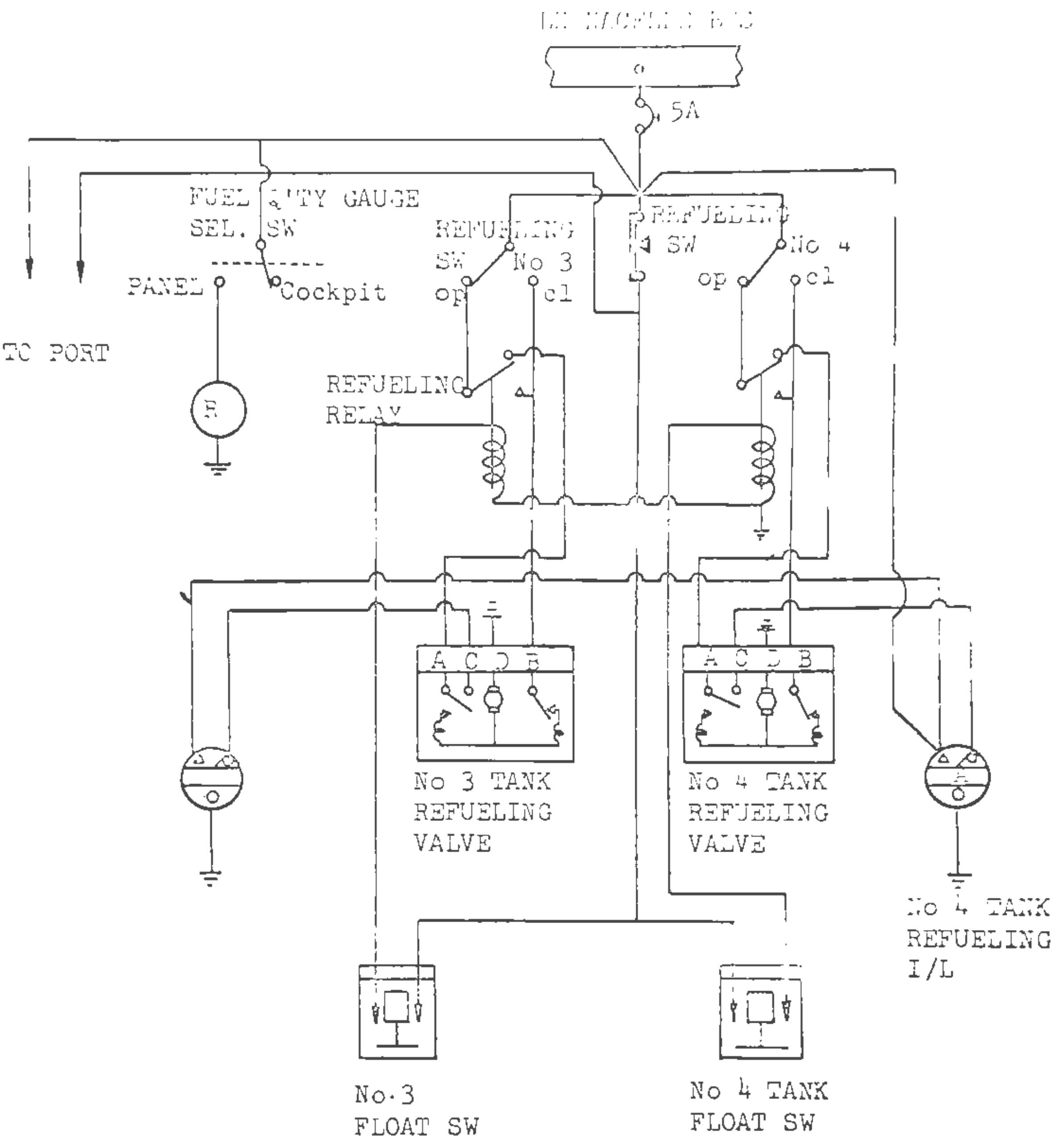
Deleted

Figure 5-8



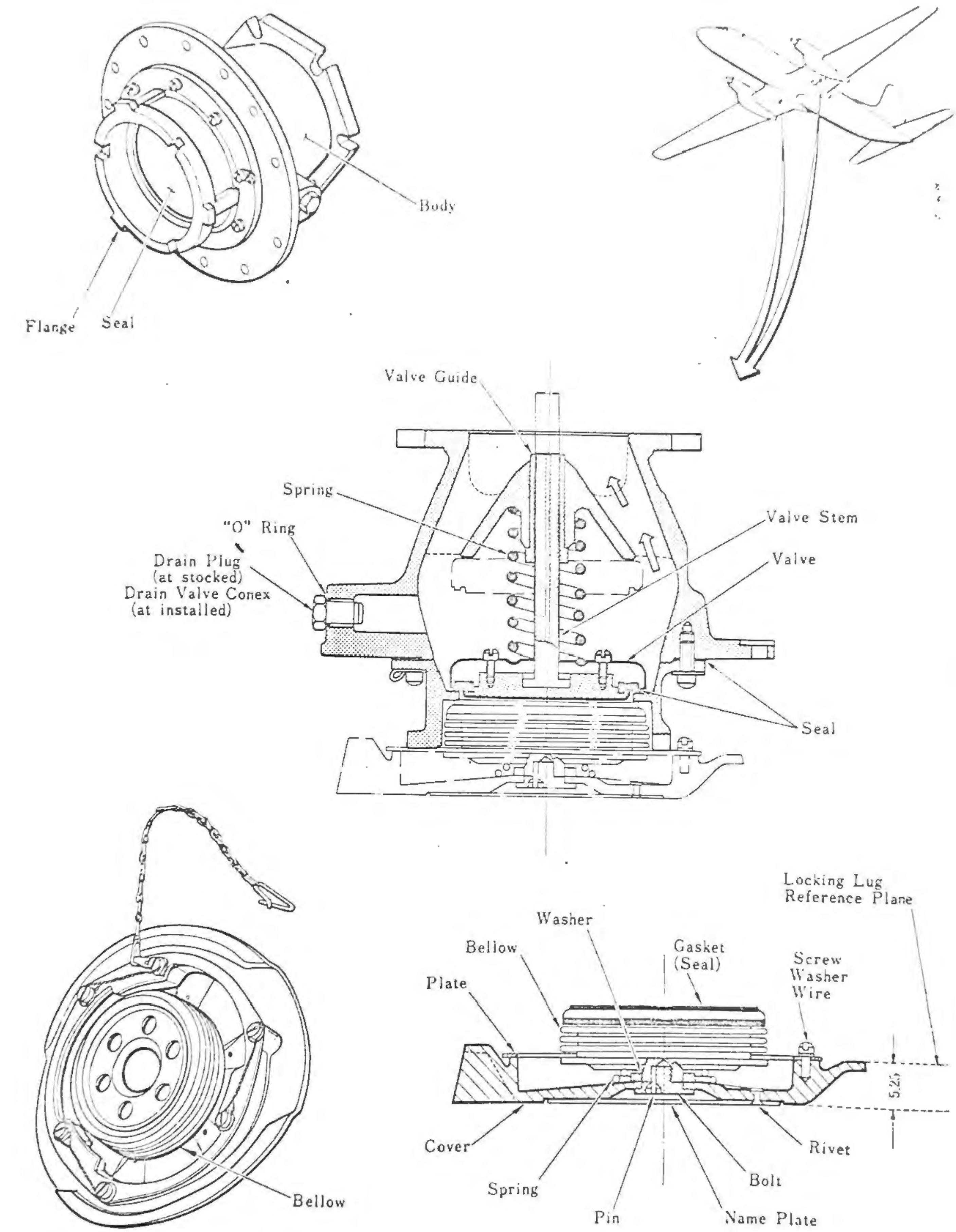
TO USE FUEL QTY GAUGE
1. EXTERNAL POWER
2. MAIN INVERTER SW(COCKPIT)"ON"
3. FUEL QTY GAUGE SELECT SW "REFUELING PANEL"
4. TANK SELECT SW REQUIRED TANK

Figure 5-8A



Pressure Refueling Electrical Schematic

Figure 5-8B

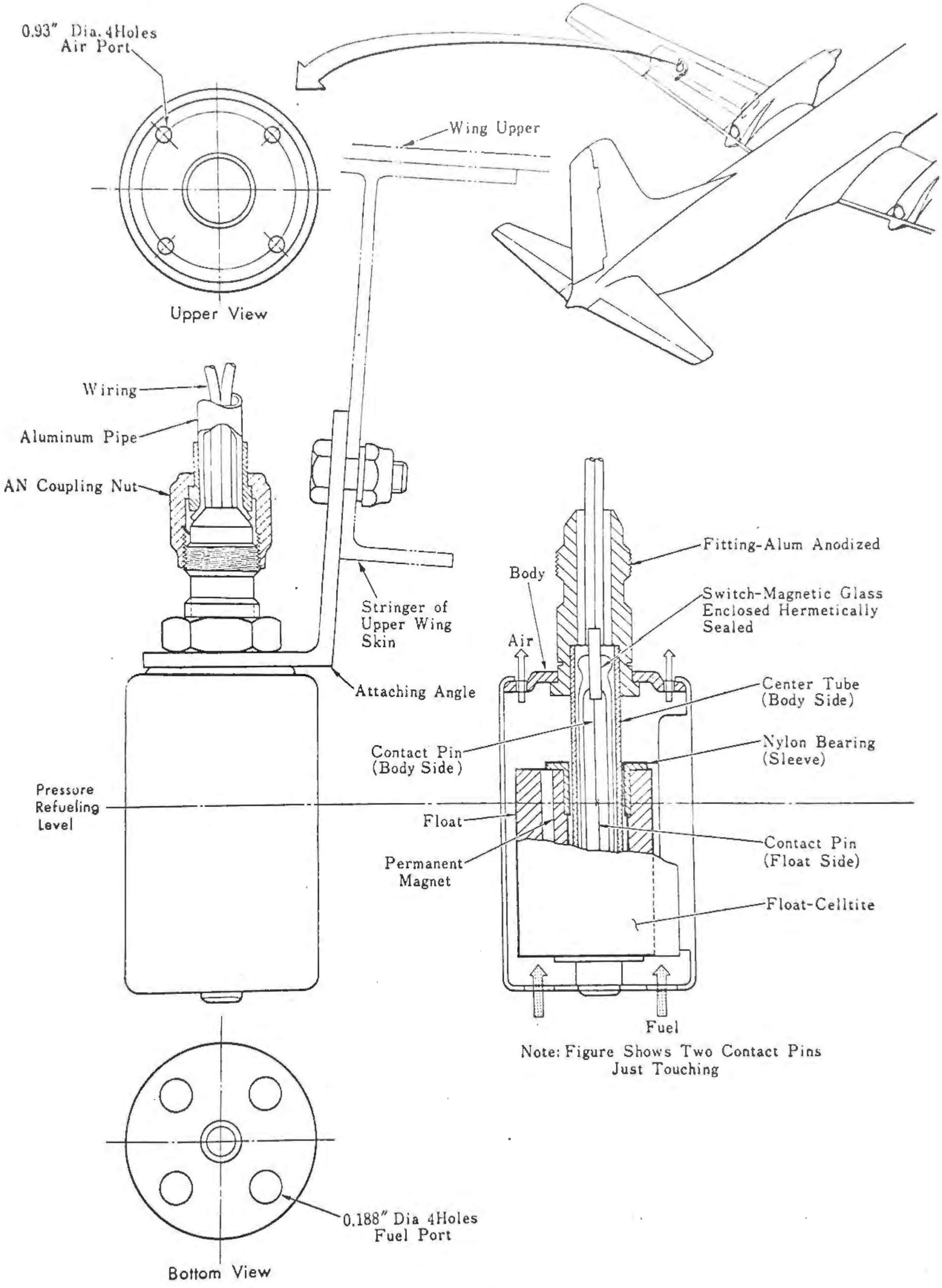


Cover Assembly Outside View

Cover Assembly

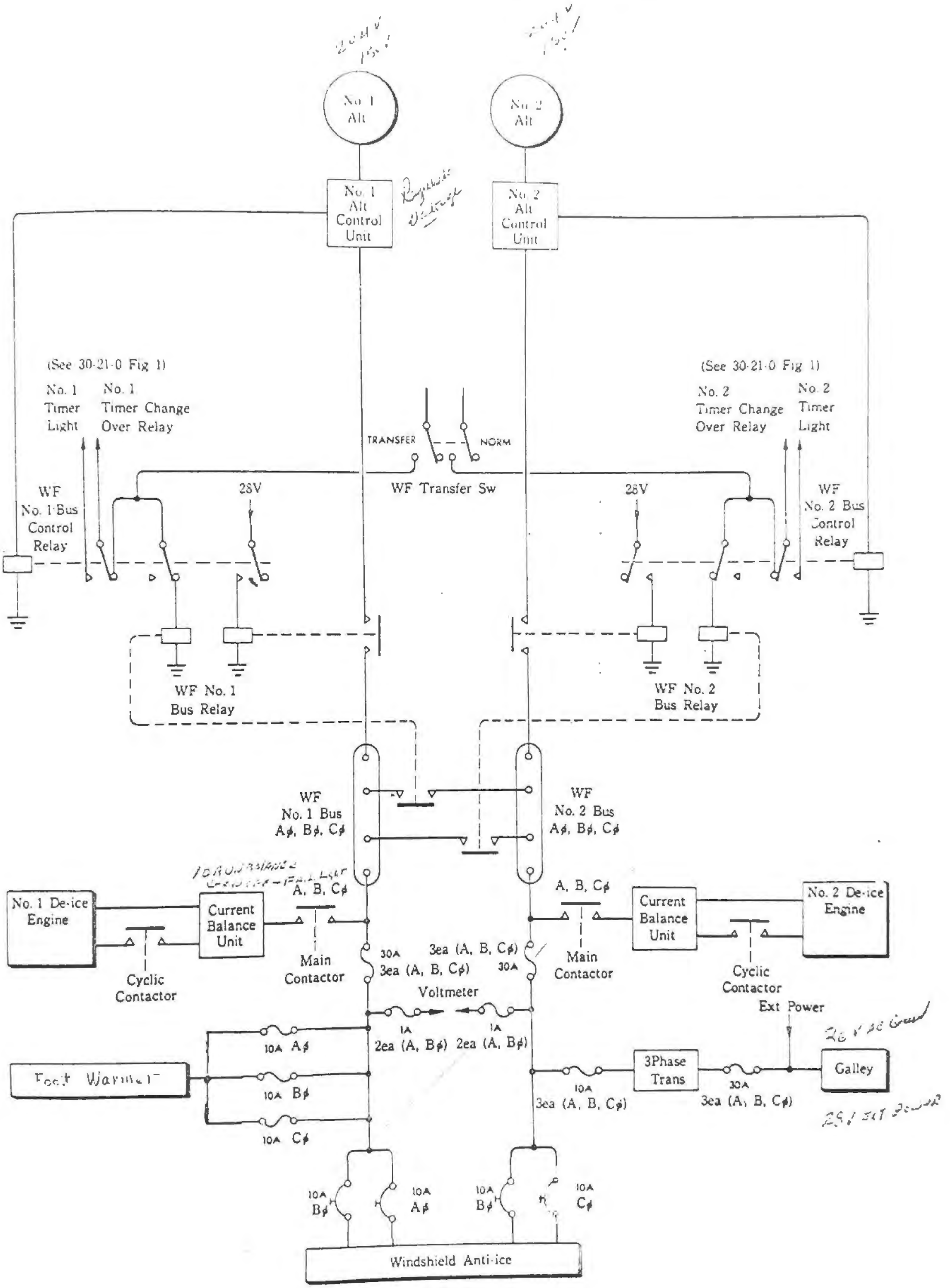
Fuel Refueling Adaptor Section View

Figure 5–9

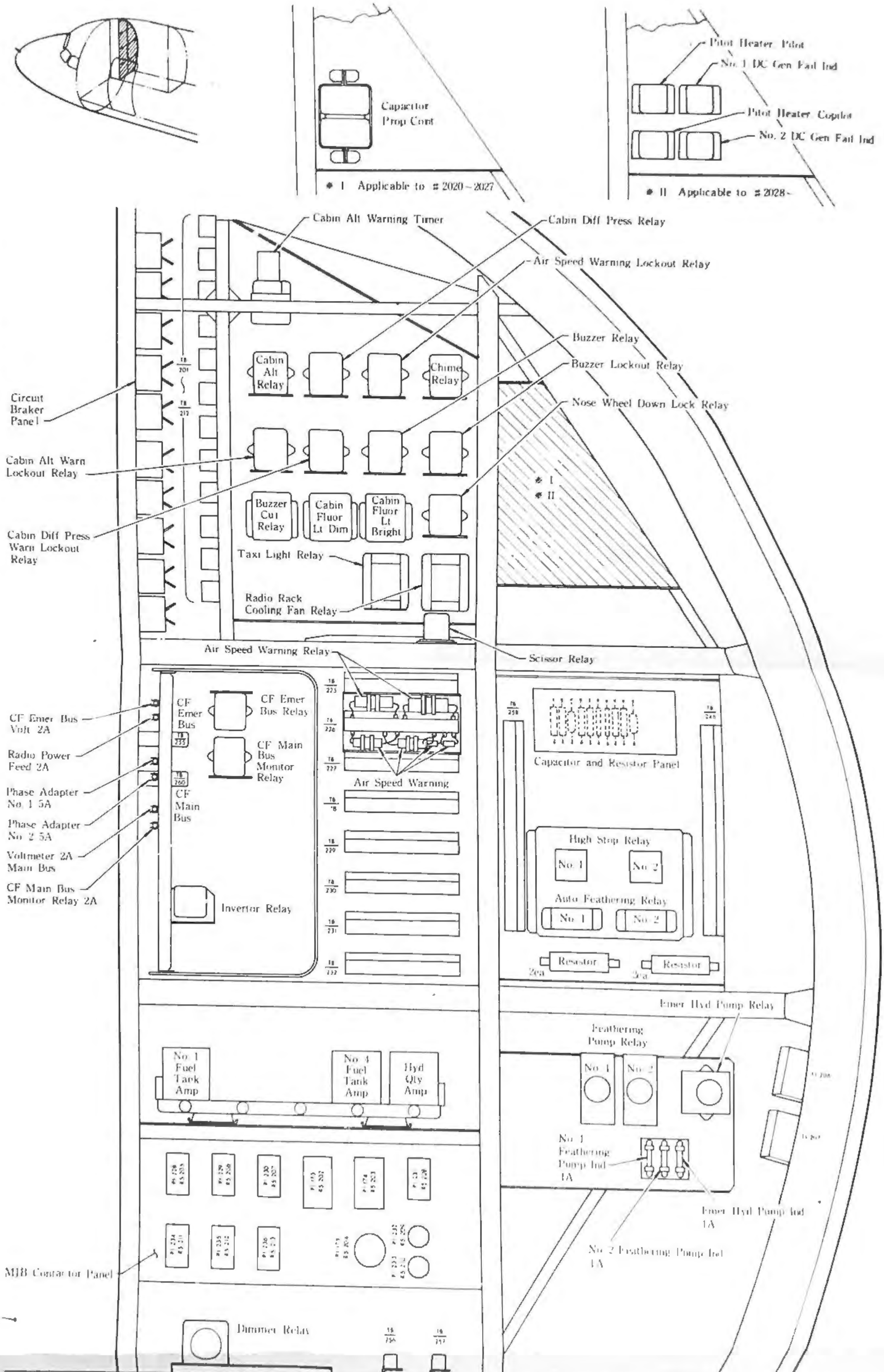


Float Switch Section View

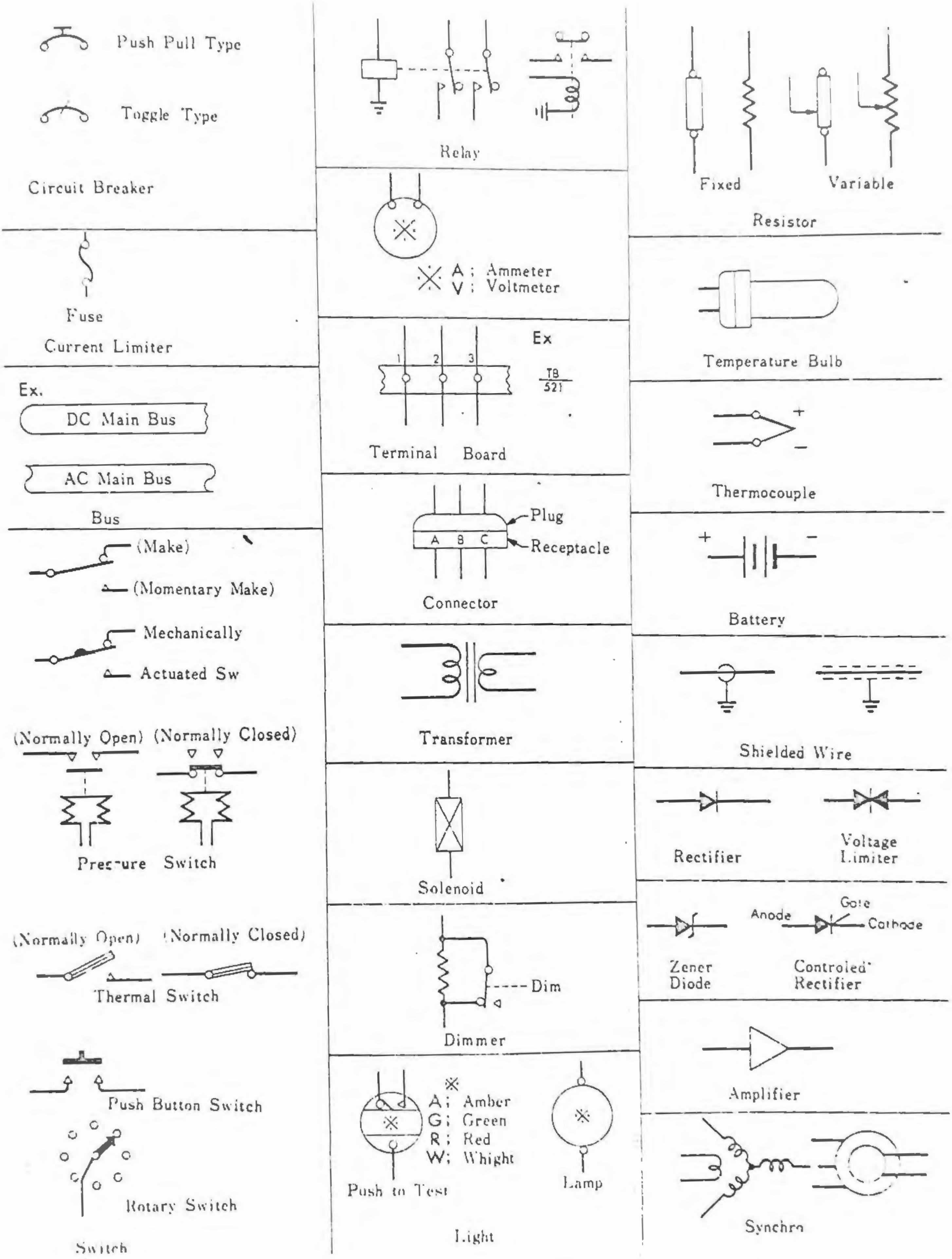
Figure 5–10



WF Power Distribution Block Diagram
Figure 9–25



Main Junction Box Aft Side Panel
Figure 9-30



Electrical Symbols im Diagram

Figure 9–33

(2) Taxi Light

A 450W lamp is clamped to the L.H. side of the nose steering cylinder with a band. As this is linked with the nose down lock, it does not come on unless the nose gear is down locked.

(3) Navigation Light

The position lights consist of a red L.H. wing tip light, green R.H. wing tip light and white tail light which do not flash.

(4) Anti-collision Light

The anti-collision lights are installed on the upper part of the fuselage (at STA-1535 to 1080) and on the lower part of the fuselage (at STA 4200 to 4680).

Two 80W lamps are mounted on a disc rotated by a motor. This disc rotates at a speed of 45 turns per minute.

(5) Ice Inspection Light

50W lamps are mounted on the L.H. and R.H. engine nacelles, illuminating the wing leading edge all the time.

9.7 Starting and Ignition System

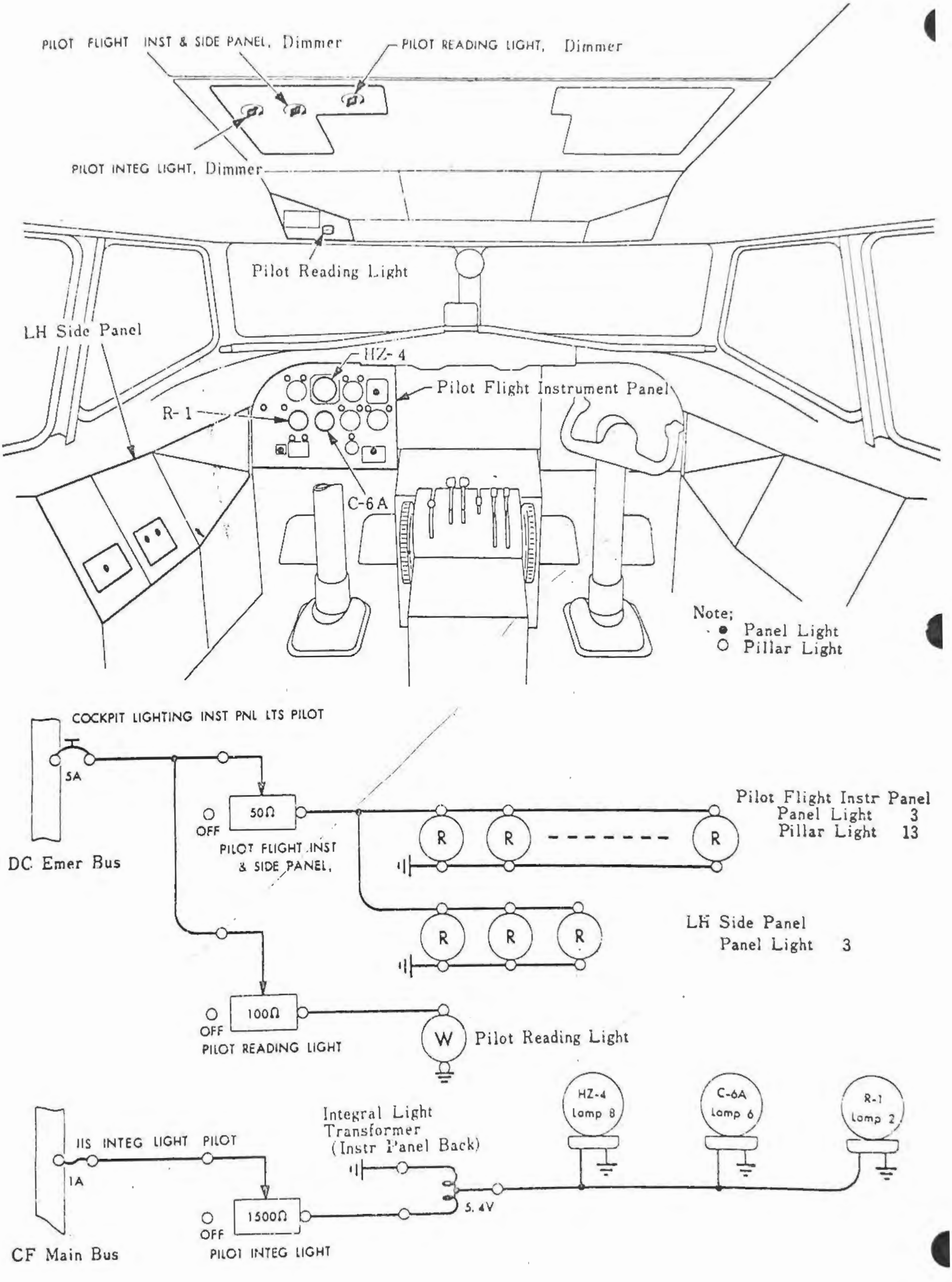
9.7.1 General

The Dart 10/1 engine is started by a starter motor operating on DC power located in Zone 1.

The engine starting is controlled by switches mounted on the overhead instrument panel and the starter is energized by means of relays installed in the main junction box, gyro compartment etc. At the same time, the high tension ignition unit generates sparks on the ignition plugs. In starting engines, either external or internal power source can be used. In case of external power starting, a ground power unit with a high capacity (approximately 2000A at the peak) is needed. In case of internal starting, Ni-Cd batteries must be installed in the aircraft. Power from the lead batteries is not sufficient for engine starting.

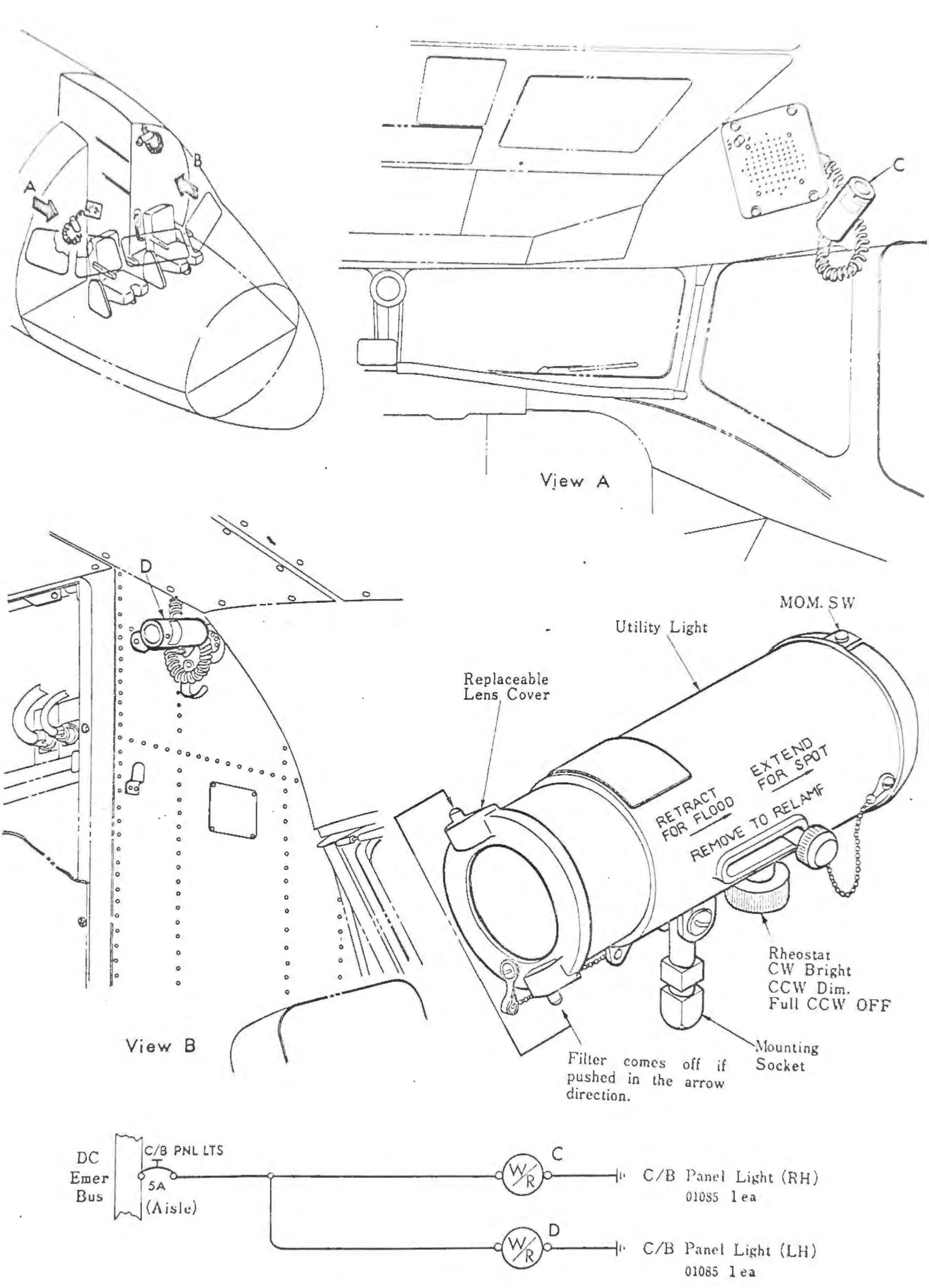
9.7.2 Starting System

The starter motor is a 17.5HP, 4 poled compound motor, avoiding overspeeding by means of the starter timer, overspeed relay and anti-crush relay. When the engine is started by external power source, a starter resistor cuts in the starter circuit, restricting the electric current. 6 sec. later, this resistor is short-circuited and the current is fed directly to the starter motor. 30 sec. later, power to the starter motor is automatically cut off. In case of failure of this timer, the overspeed relay is energized to cut off the current of the starter circuit.

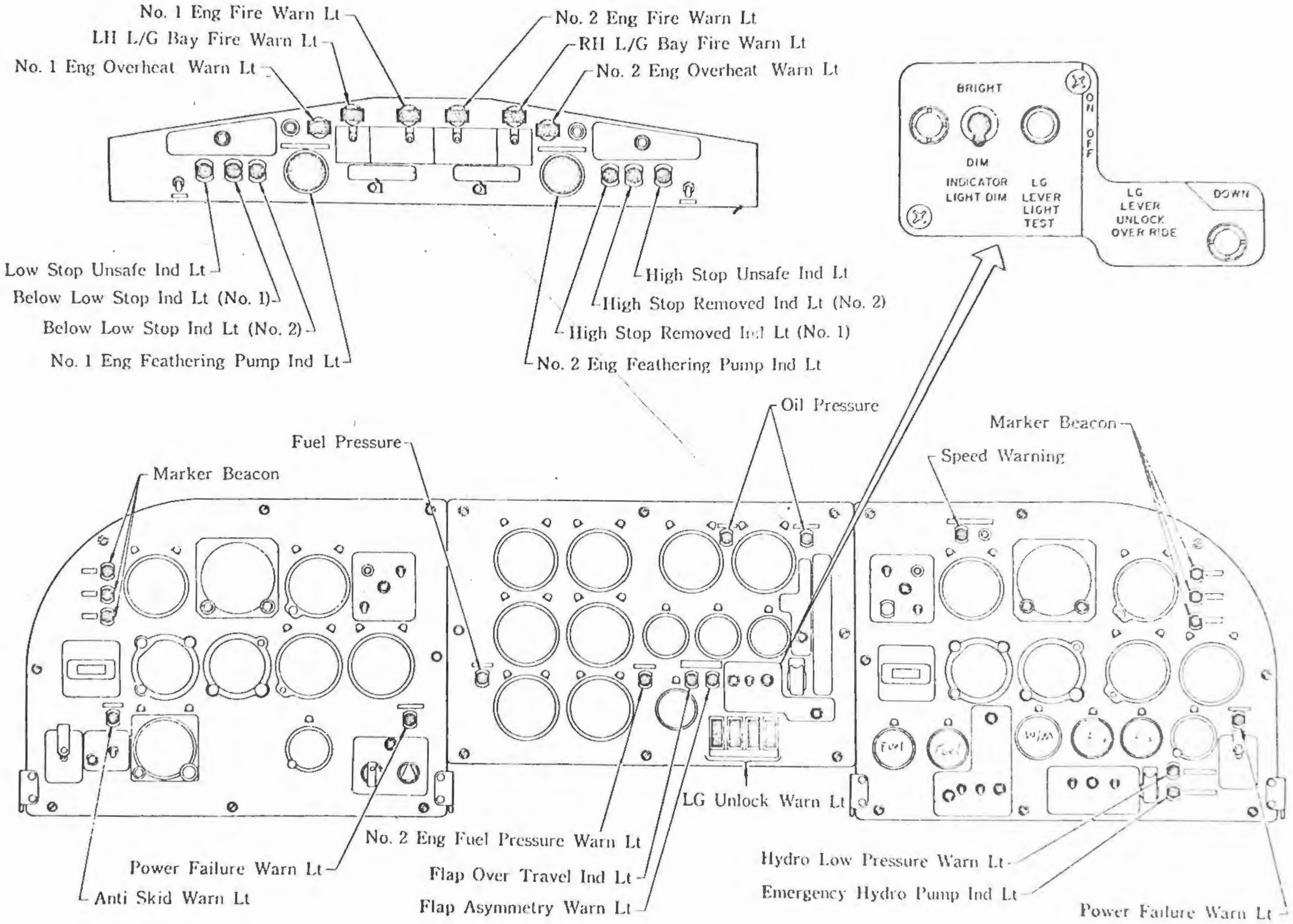


Pilot's Side Lighting System

Figure 9–35



Circuit Breaker Panel Light
Figure 9–39

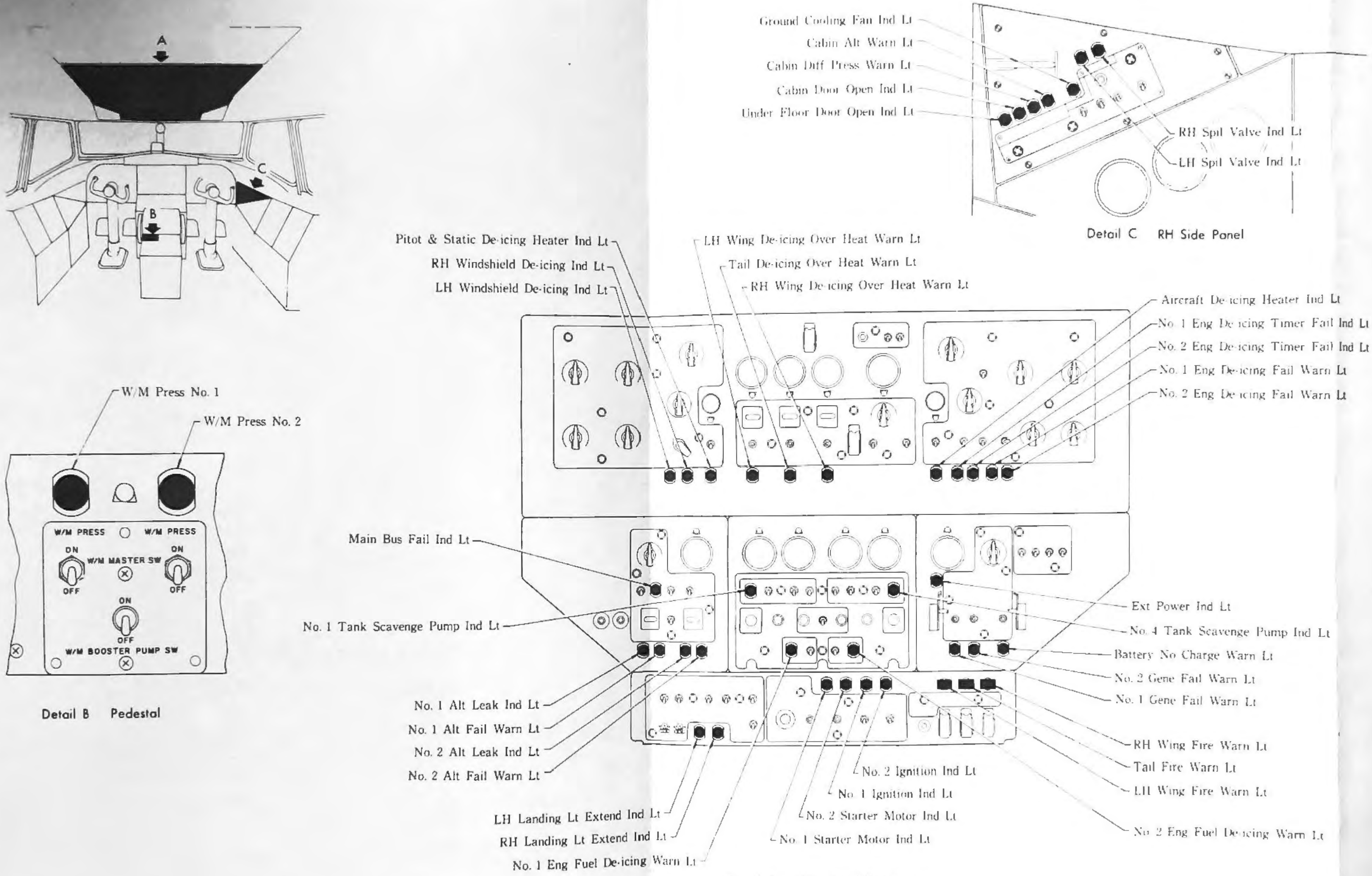


Main & Auxiliary Instrument Panel Warning & Indicating Light
Figure 9–40

If the starter button is kept pushed in, the starter motor does not turn the engine again due to the functions of the anti-crush relay. In case of internal power starting, the starter resistor does not cut in the power source circuit. That is to say, power is directly fed to the starter motor.

9.7.3 Ignition System

On the shear panel in Zone 3 of the engine are mounted two high tension units which supply high voltage current of DC 2000V to spark plugs located in No. 3 and No. 7 combustion chambers. In the high tension unit are contained a reservoir capacitor, discharge gap, ionizing spark gap and protection resistor for voltage of good quality.



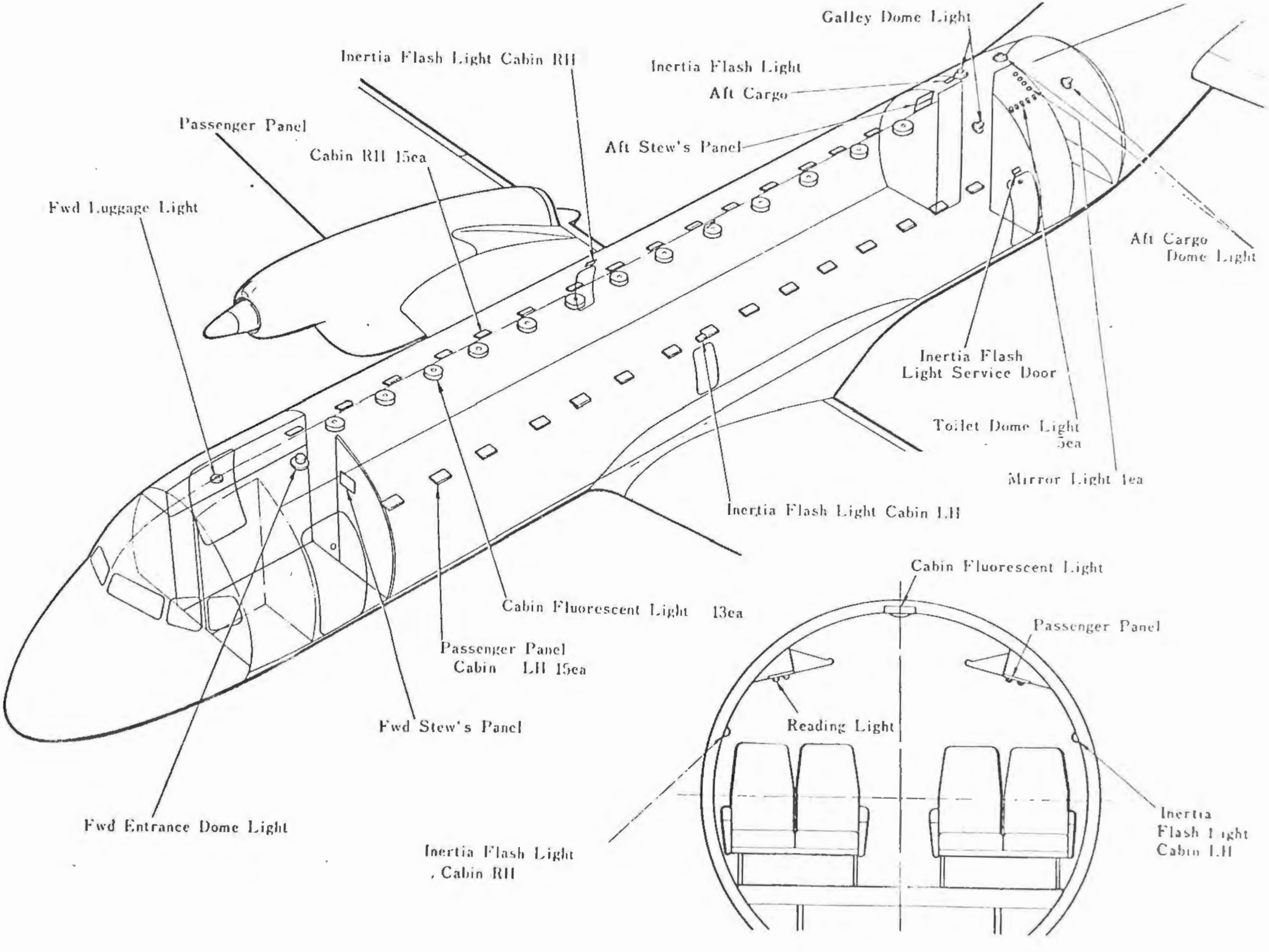
A
B
C
Ground Cooling Fan Ind Lt
Cabin Alt Warn Lt
Cabin Diff Press Warn Lt
Cabin Door Open Ind Lt
Under Floor Door Open Ind Lt
RH Spil Valve Ind Lt
LH Spil Valve Ind Lt
Pitot & Static De-icing Heater Ind Lt
RH Windshield De-icing Ind Lt
LH Windshield De-icing Ind Lt
LH Wing De-icing Over Heat Warn Lt
Tail De-icing Over Heat Warn Lt
RH Wing De-icing Over Heat Warn Lt
Aircraft De-icing Heater Ind Lt
No. 1 Eng De-icing Timer Fail Ind Lt
No. 2 Eng De-icing Timer Fail Ind Lt
No. 1 Eng De-icing Fail Warn Lt
No. 2 Eng De-icing Fail Warn Lt
W/M Press No. 1
W/M Press No. 2
W/M PRESS
W/M PRESS
ON
W/M MASTER SW
ON
OFF
OFF
ON
OFF
W/M BOOSTER PUMP SW
Main Bus Fail Ind Lt
No. 1 Tank Scavenge Pump Ind Lt
Ext Power Ind Lt
No. 4 Tank Scavenge Pump Ind Lt
Battery No Charge Warn Lt
No. 2 Gene Fail Warn Lt
No. 1 Gene Fail Warn Lt
No. 1 Alt Leak Ind Lt
No. 1 Alt Fail Warn Lt
No. 2 Alt Leak Ind Lt
No. 2 Alt Fail Warn Lt
RH Wing Fire Warn Lt
Tail Fire Warn Lt
LH Wing Fire Warn Lt
No. 2 Ignition Ind Lt
No. 1 Ignition Ind Lt
No. 2 Starter Motor Ind Lt
No. 1 Starter Motor Ind Lt
No. 2 Eng Fuel De-icing Warn Lt
LH Landing Lt Extend Ind Lt
RH Landing Lt Extend Ind Lt
No. 1 Eng Fuel De-icing Warn Lt

Detail C RH Side Panel

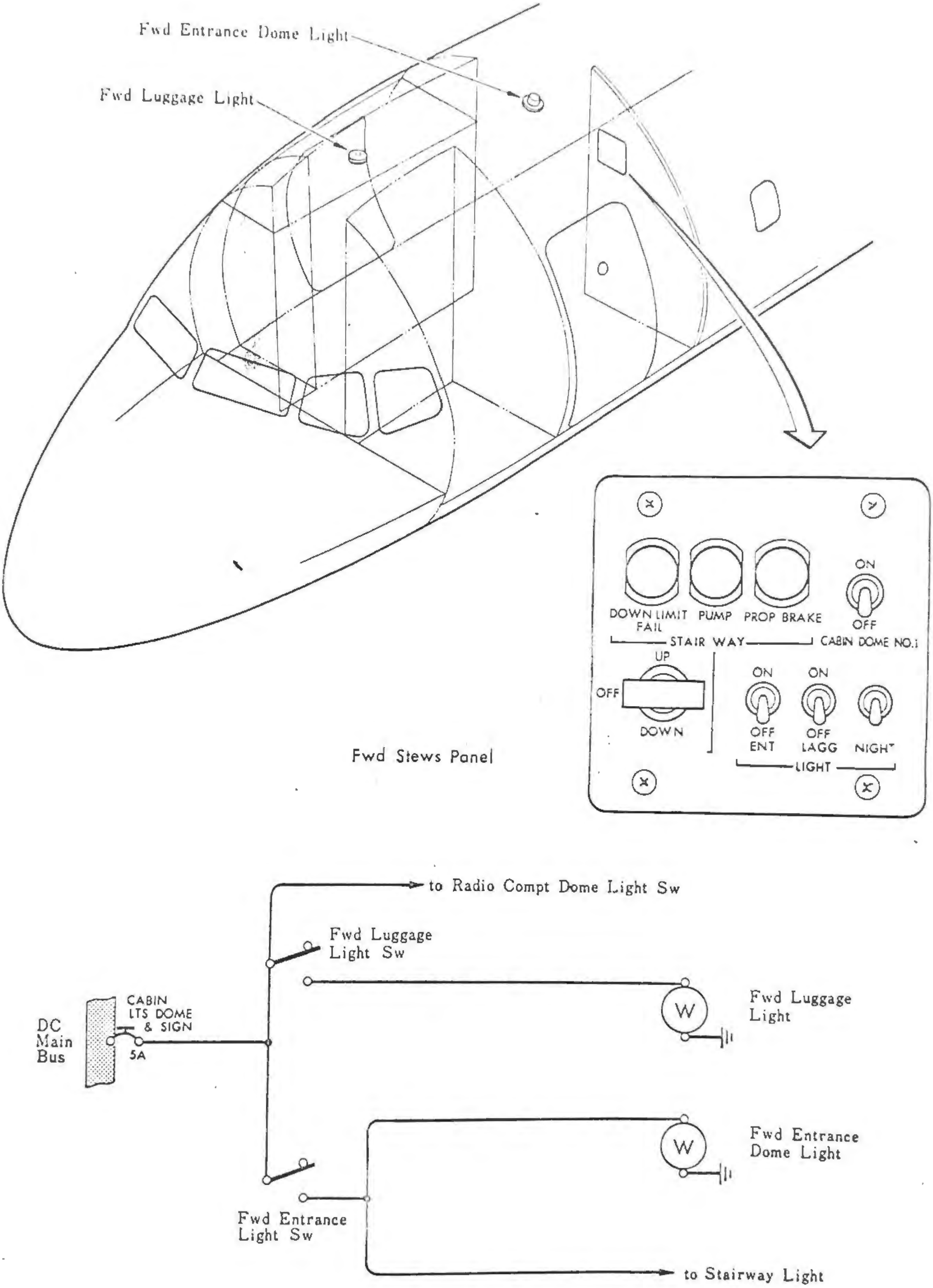
Detail B Pedestal

Detail A Overhead Panel

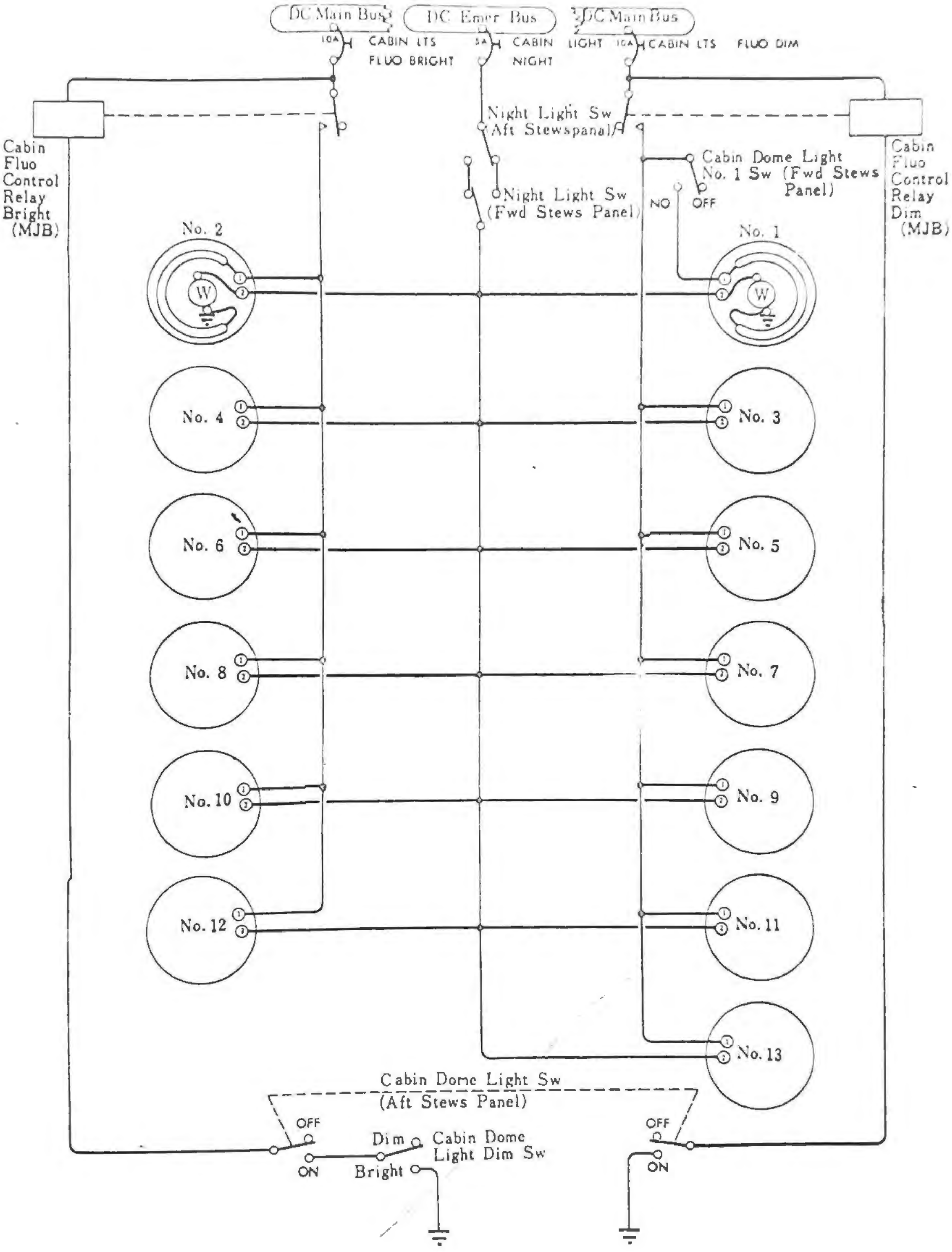
Overhead and RH Side Panel and Pedestal, and Indicating Light
Figure 9–41



Passenger Compartments Lighting General Arrangement
Figure 9-42

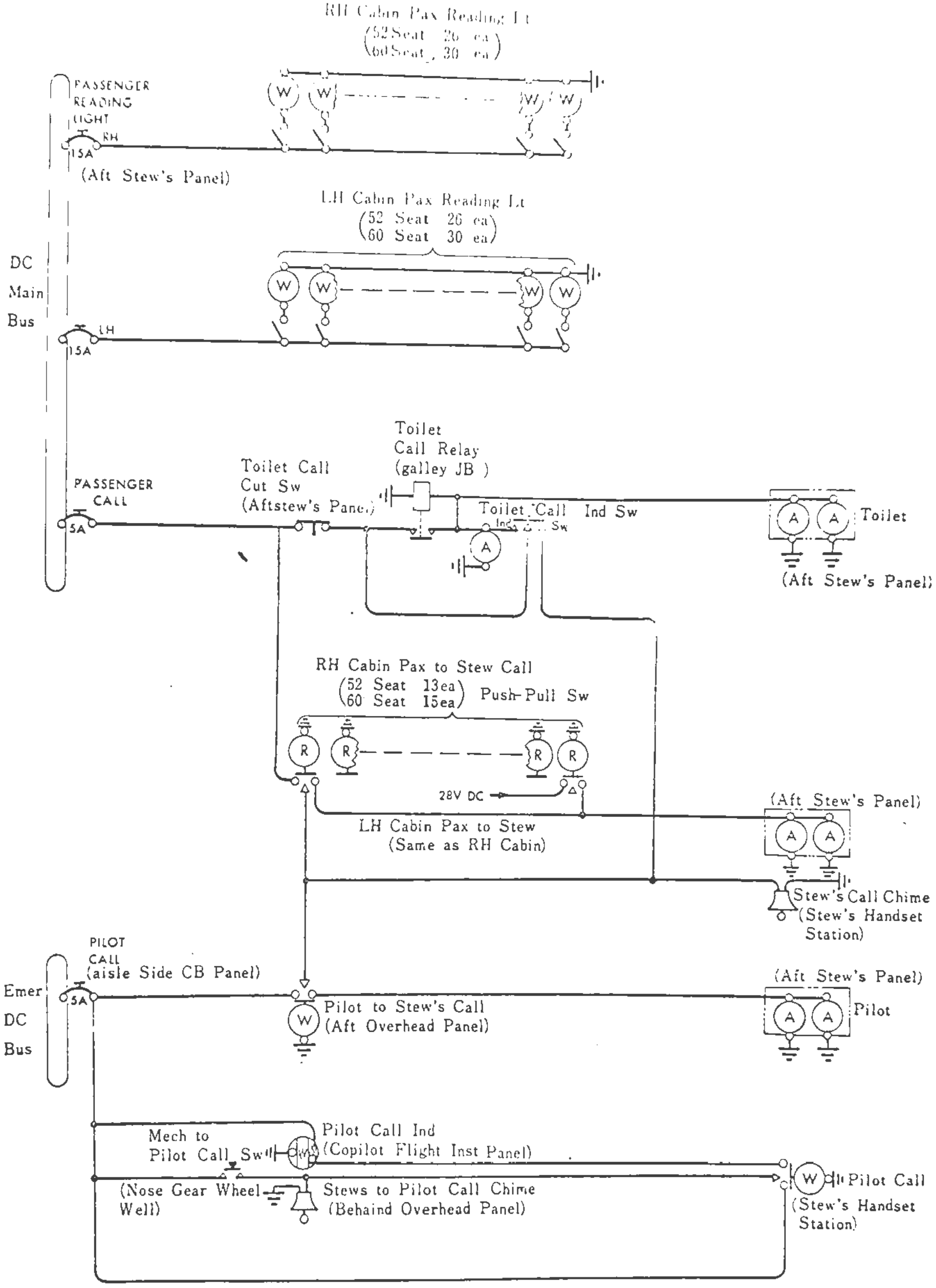


Entrance Light
Figure 9–43



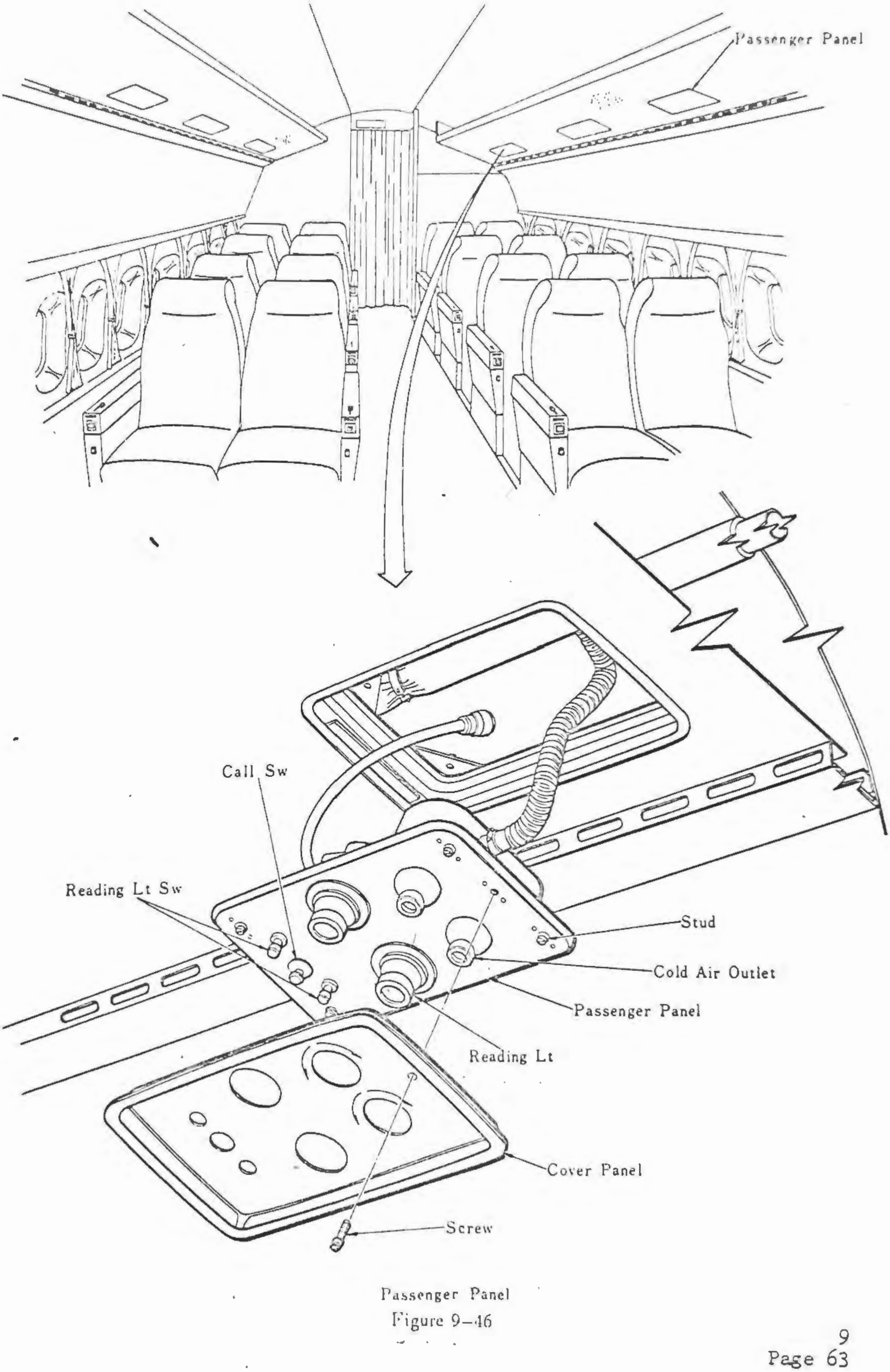
Cabin Lights Schematic Diagram

Figure 9—44

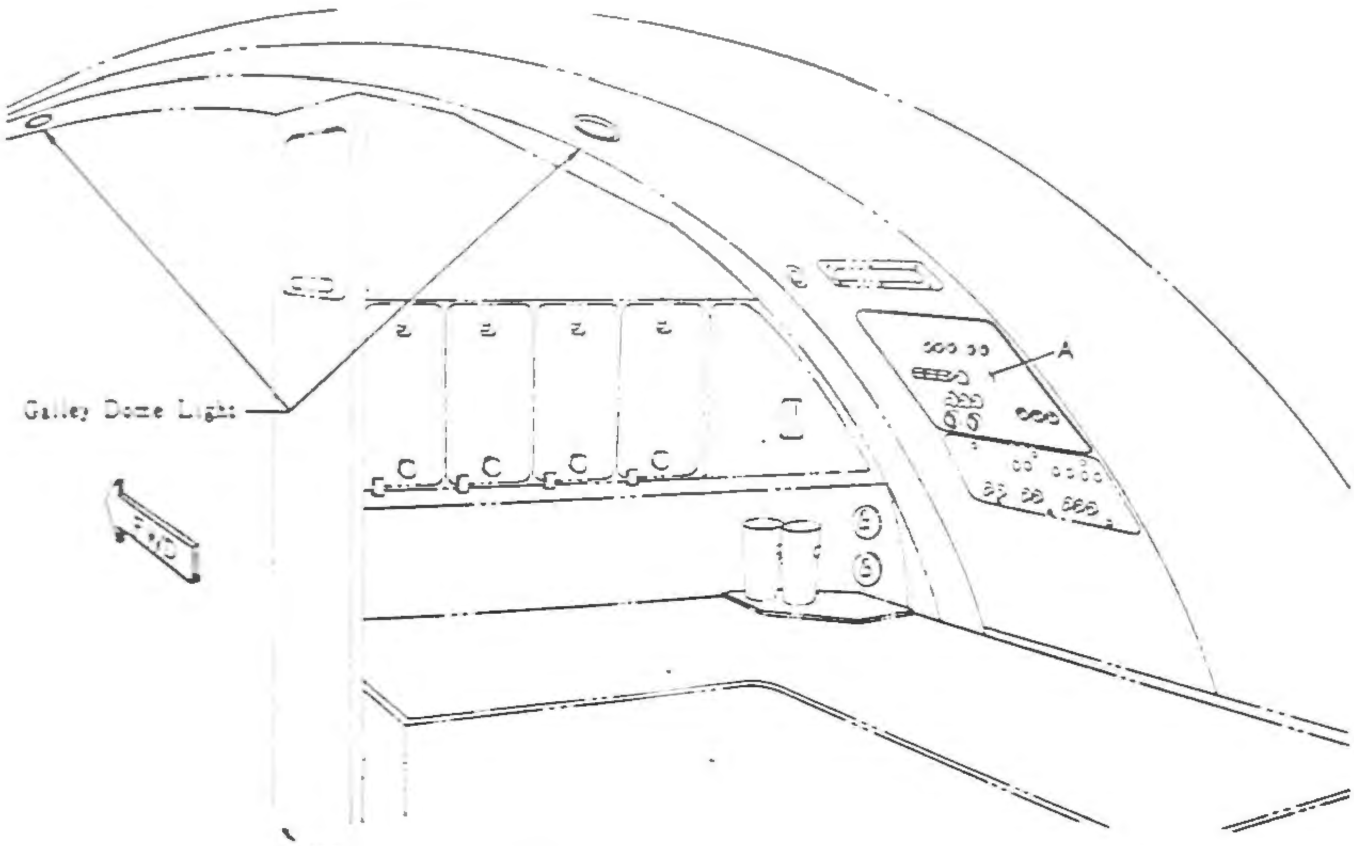


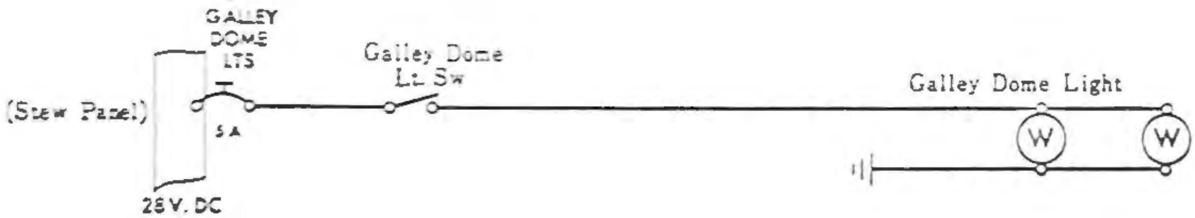
Call System and Reading Light Wiring Schematic

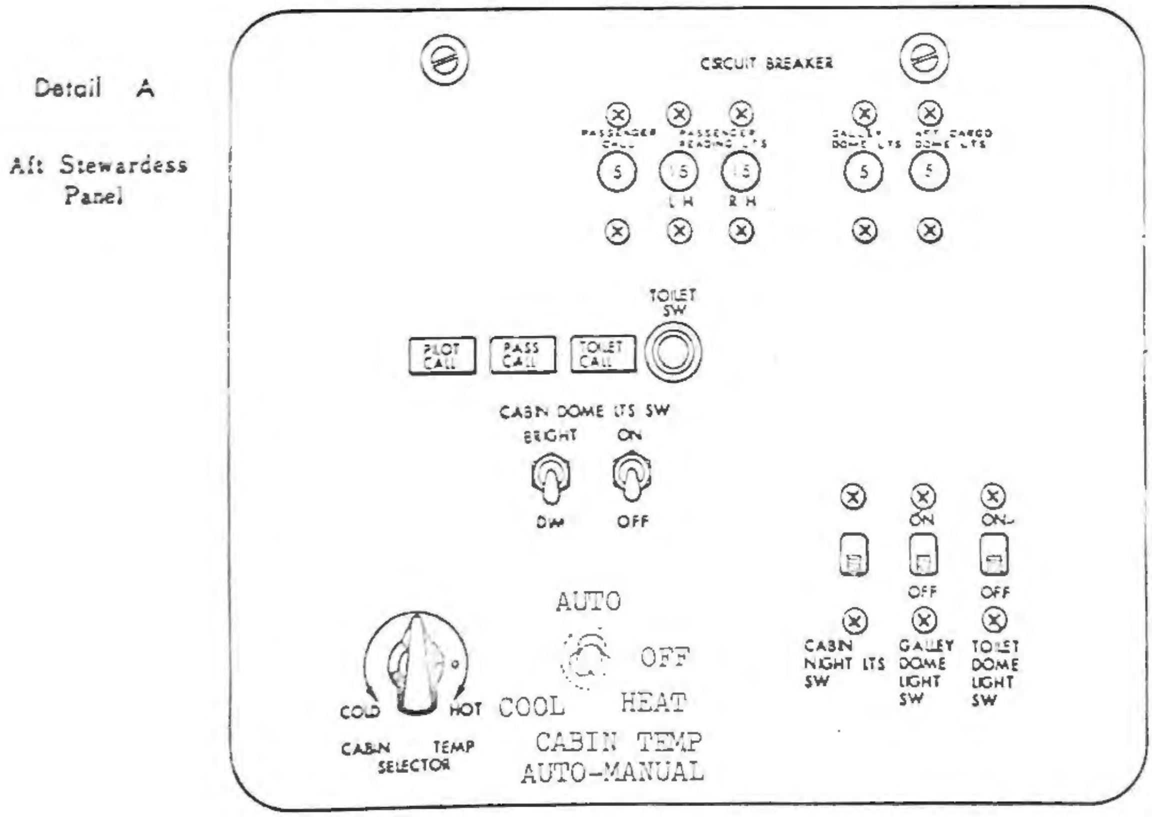
Figure 9–45



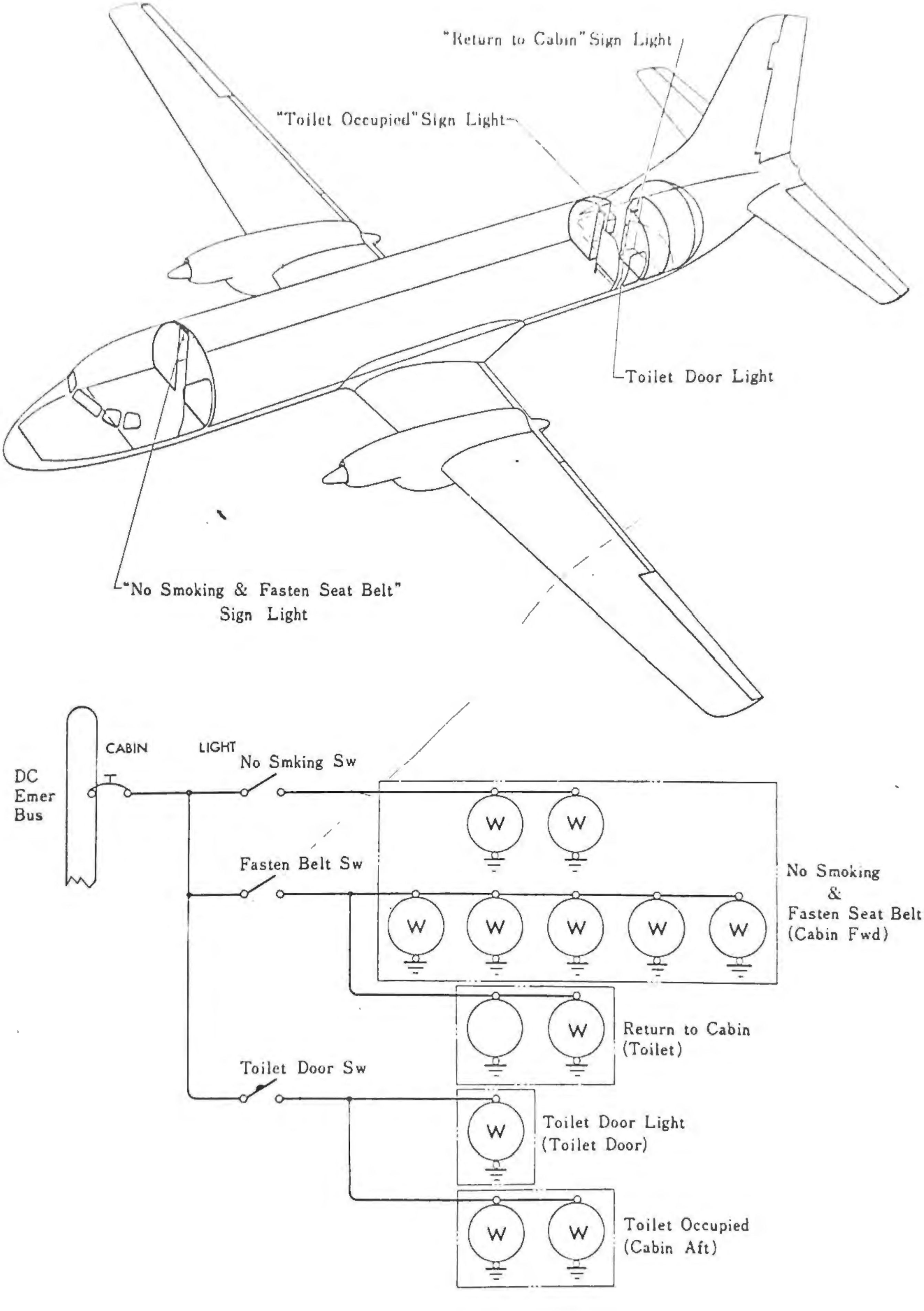
Passenger Panel
Figure 9-46



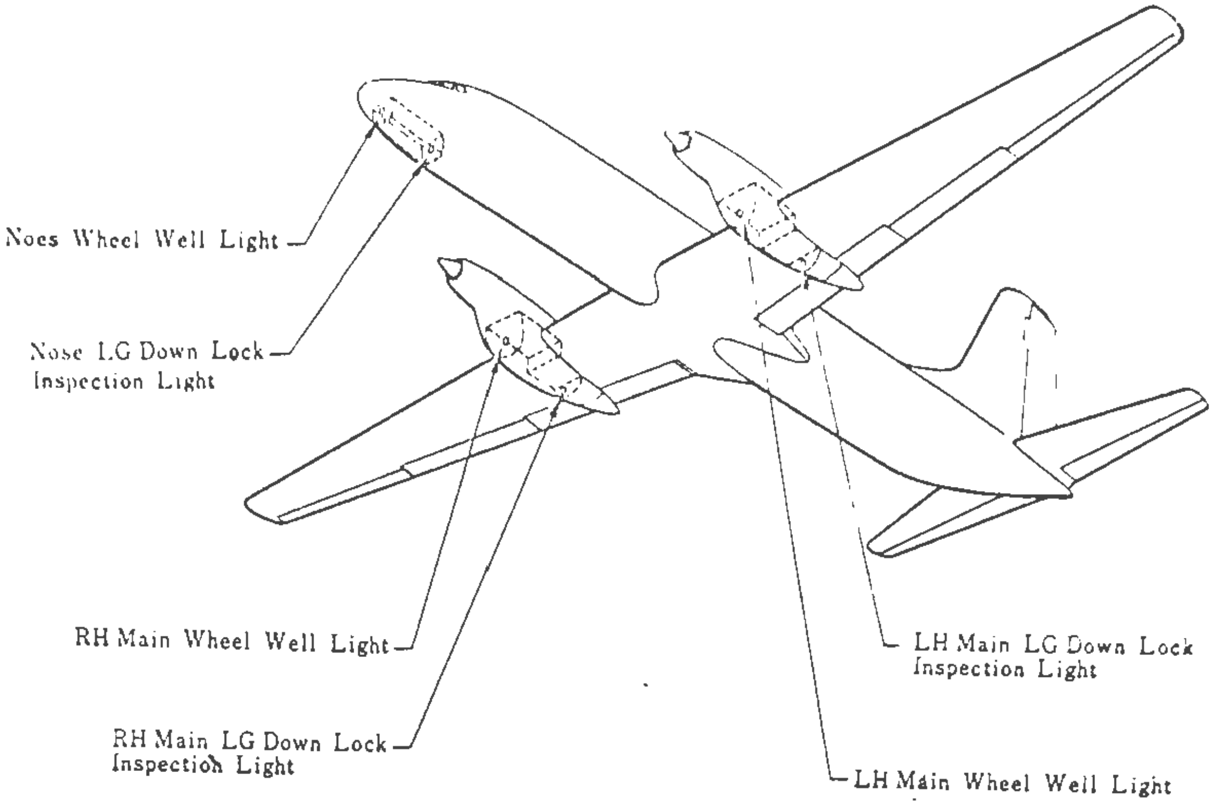




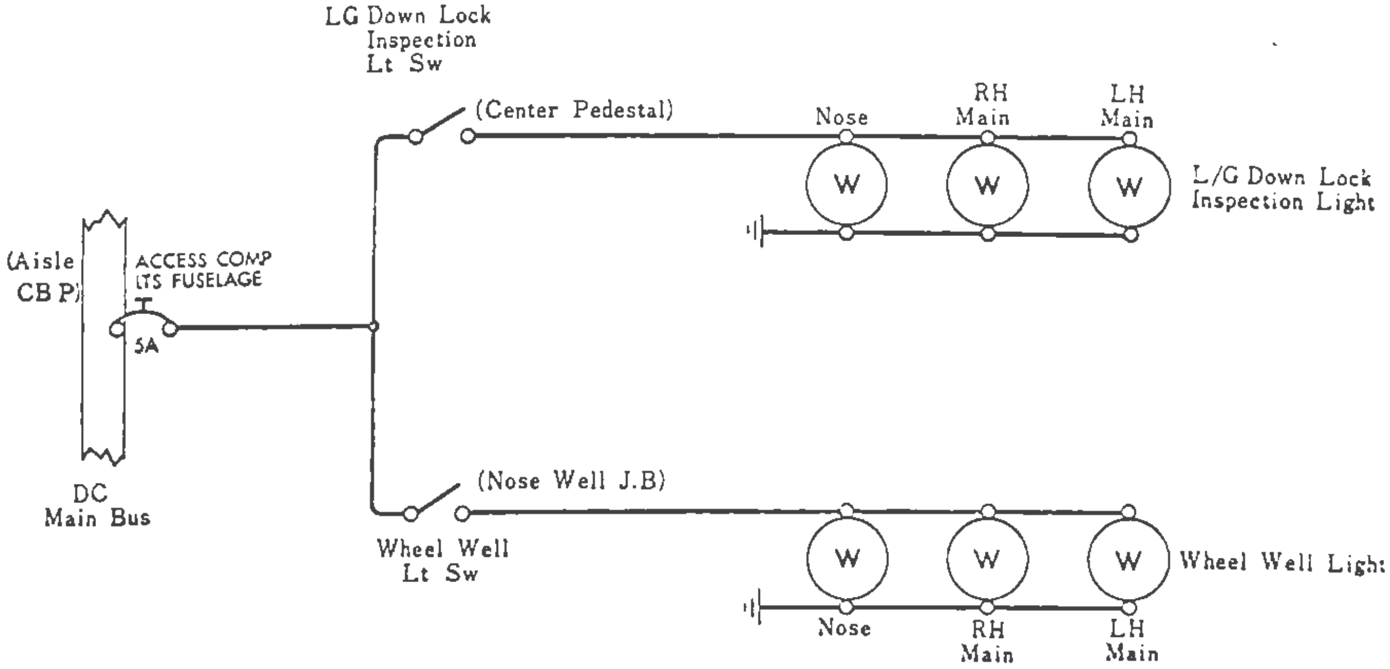
Galley Dome Light and Aft Stewardess Panel
Figure 9-48


"Return to Cabin" Sign Light
"Toilet Occupied" Sign Light
Toilet Door Light
"No Smoking & Fasten Seat Belt" Sign Light
DC Emer Bus
CABIN LIGHT
No Smking Sw
Fasten Belt Sw
Toilet Door Sw
W
No Smoking & Fasten Seat Belt (Cabin Fwd)
Return to Cabin (Toilet)
Toilet Door Light (Toilet Door)
Toilet Occupied (Cabin Aft)

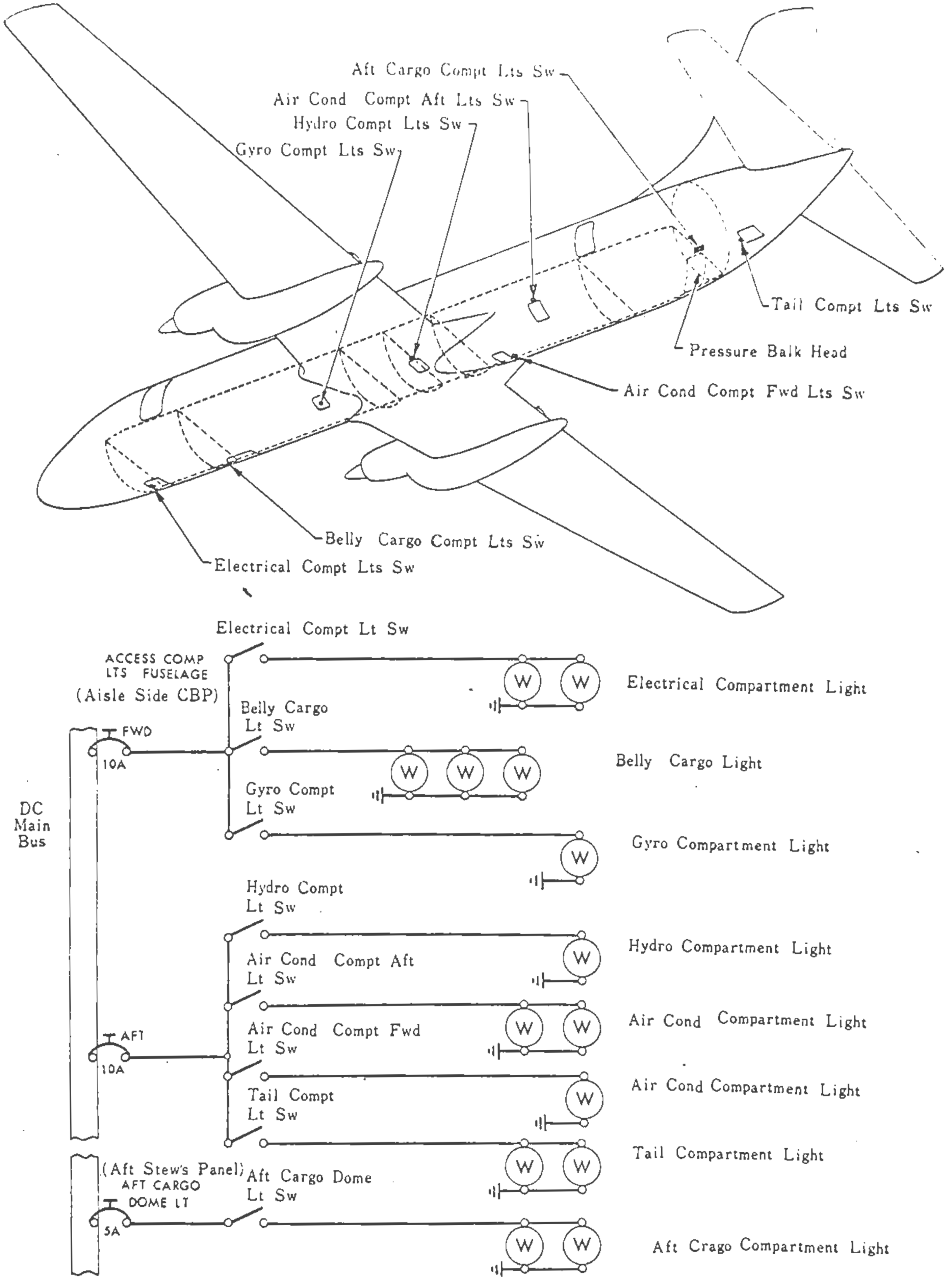
Ordinance Light
Figure 9–49



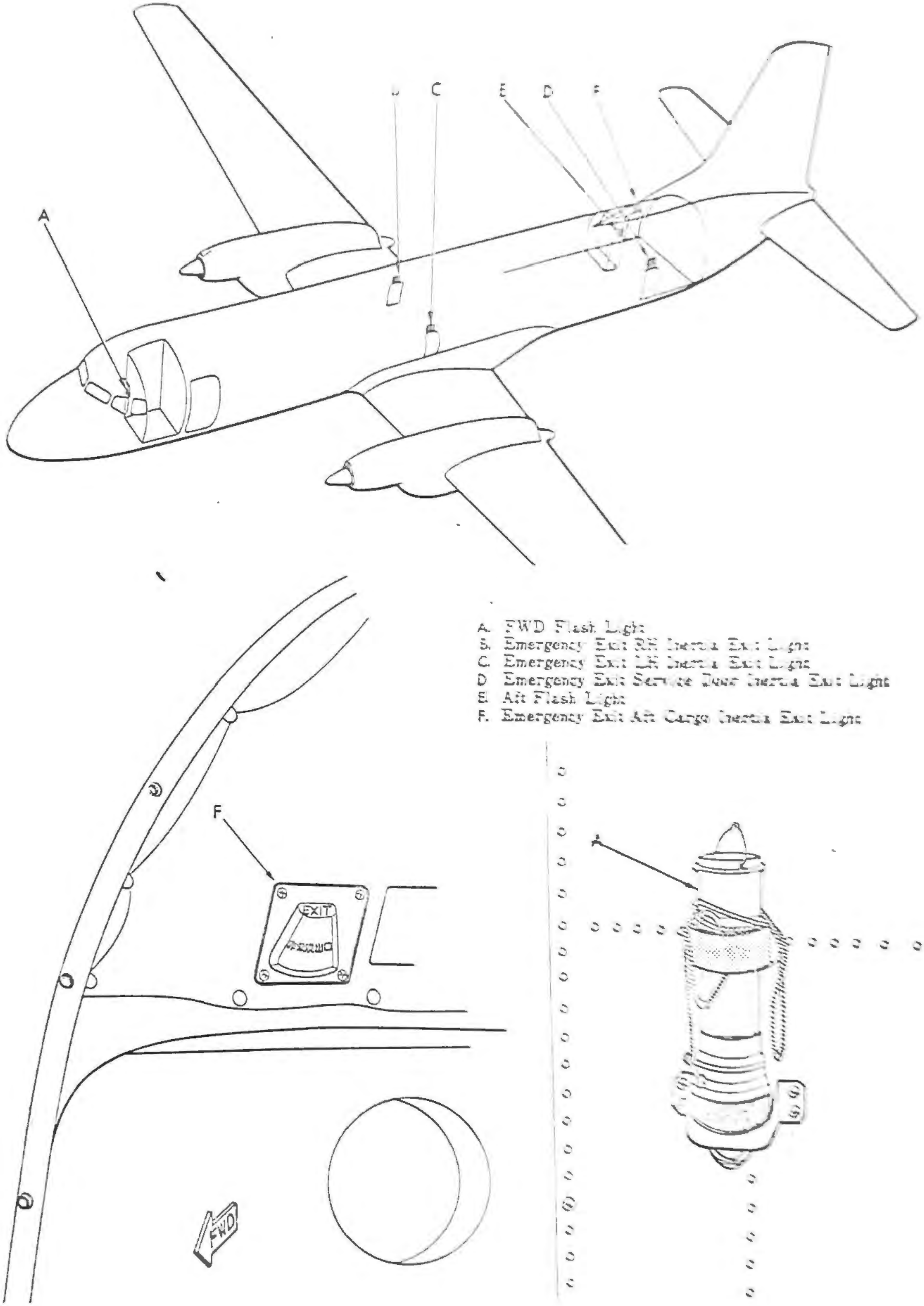
Noes Wheel Well Light
Nose LG Down Lock Inspection Light
RH Main Wheel Well Light
RH Main LG Down Lock Inspection Light
LH Main LG Down Lock Inspection Light
LH Main Wheel Well Light



Wheel Well Light
Figure 9–50

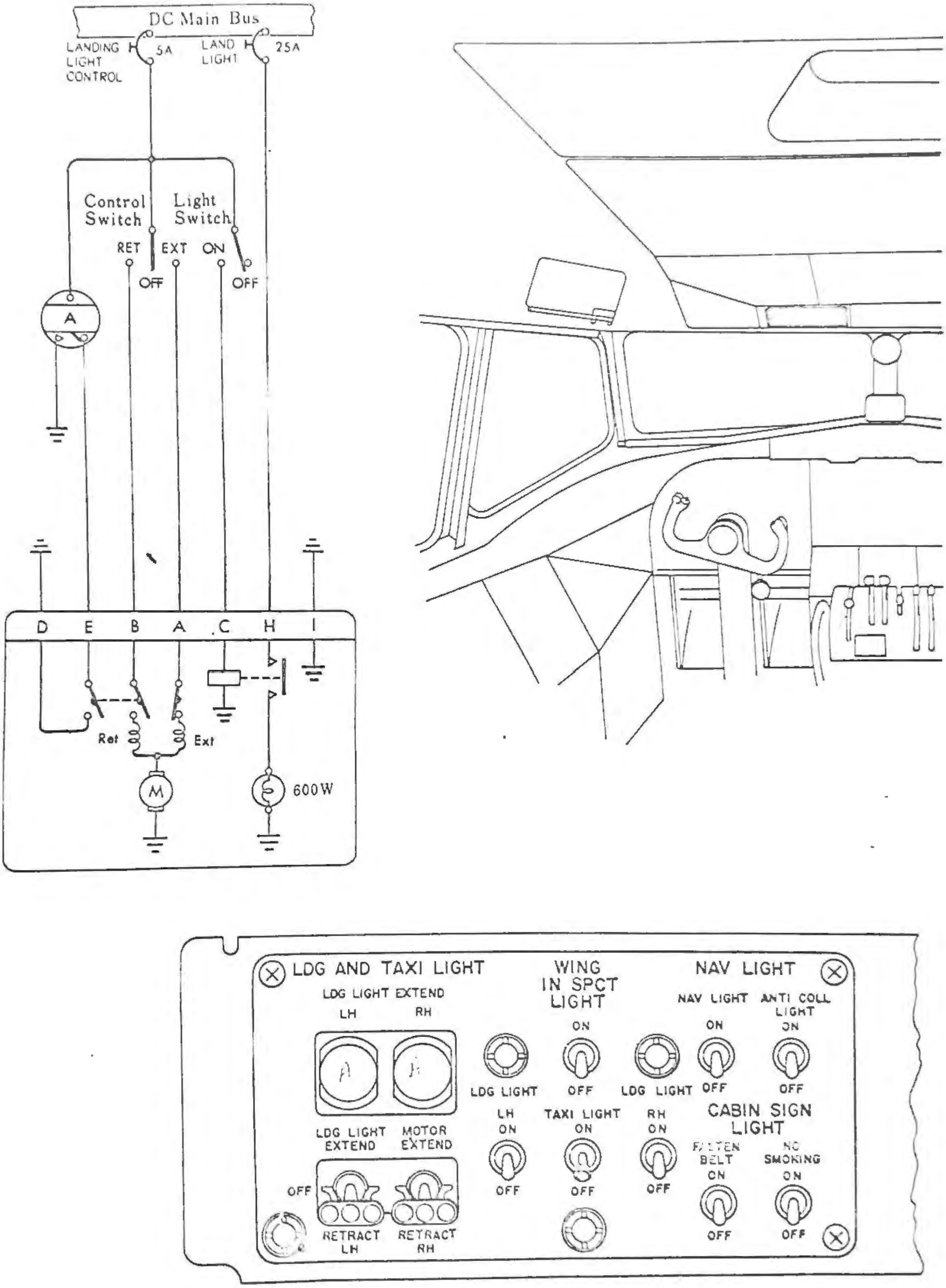


Cargo and Service Compartment Wiring Schematic
Figure 9–51



A. FWD Flash Light
B. Emergency Exit RH Inertia Exit Light
C. Emergency Exit LH Inertia Exit Light
D. Emergency Exit Service Door Inertia Exit Light
E. Aft Flash Light
F. Emergency Exit Aft Cargo Inertia Exit Light

Emergency Lights Arrangement
Figure 9–52



Landing Light Schematic Diagram
Figure 9–54

(5) Adapter	Control panel
(6) Drain valve	Adapter

On the refueling control panel are arranged four switches for operating the shut-off valve, four amber lights for indicating the valve position (close or open), and one interphone jack. In addition, the panel is provided with the fuel quantity indicator, its changeover switch and the tank selector switch.

Adapter in fuel refueling port is check valve type adapter and prevents fuel from flowing in reverse direction. Connect the refueling nozzle to the adapter and turn the control switch "ON," then the refueling shut-off valve on the refueling line opens, and simultaneously the indicating light comes on.

When the fuel flows into the tank to raise the fuel level to the prescribed one, the float switch closes the contact point to close the shut-off valve automatically.

Thus, refueling is accomplished and the refueling indicating light on the control panel goes out. When the amount of fuel in tanks is below the prescribed level, the control switch shall be turned to close the refueling shut-off valve. The interphone jack is used to contact the crew in the cockpit while refueling. The fuel quantity indication is shown either on the cockpit side or the panel side indicator by means of the changeover switch. The fuel quantity for each tank can be indicated by the tank select switch.

NOTE: As to the interphone circuit, see Chapter 10 ELECTRONIC SYSTEM.

The pressure relief valve is provided on the lower surface of the wing for the protection of the tank from excessive internal pressure be relieving it through the valve. In case when refueling can not be stopped due to defective float switch, the pressure relief valve opens. Opening pressure is 1.75 to 1.5 psi.

As the refueling control system power is supplied from the battery bus, the use of a control switch in the cockpit is not necessary.

A. Adapter (See Fig. 5-9)

It is an aircraft coupling which is placed automatically in open position when the refueling nozzle is connected. As a cap is mounted on it, the adapter becomes a double leakage-prevention device. Adapter is proof-tested against internal pressure -3 to 120 psi and external pressure 0 to 120 psi respectively for preventing leakage.

B. Drain Valve (See Fig. 5-9)

This valve is mounted directly on one side of the adapter. By opening this valve, not only the fuel within the adapter but also the fuel in the pipe leading up to the refueling shut off valve can be drained.

C. Shut-off Valve

One shut-off valve is installed in refueling line of each of the left- and right-hand side wings. This valve is electrically operated, and is to open or close the path of the refueling line.

D. Float Switch (See Fig. 5-10)

One float switch is installed in each tank. When the tank level reaches the prescribed one during refueling, the float switch actuates the refueling relays to close the shut-off valve automatically.

E. In the L.H. refueling pipe is provided an orifice which regulates the L.H. and R.H. fuel flows.

5.4 Fuel Feed System

Fuel is fed to either engine from the main tank. Fuel in the auxiliary tank is transferred to main tanks to be fed to the engines.

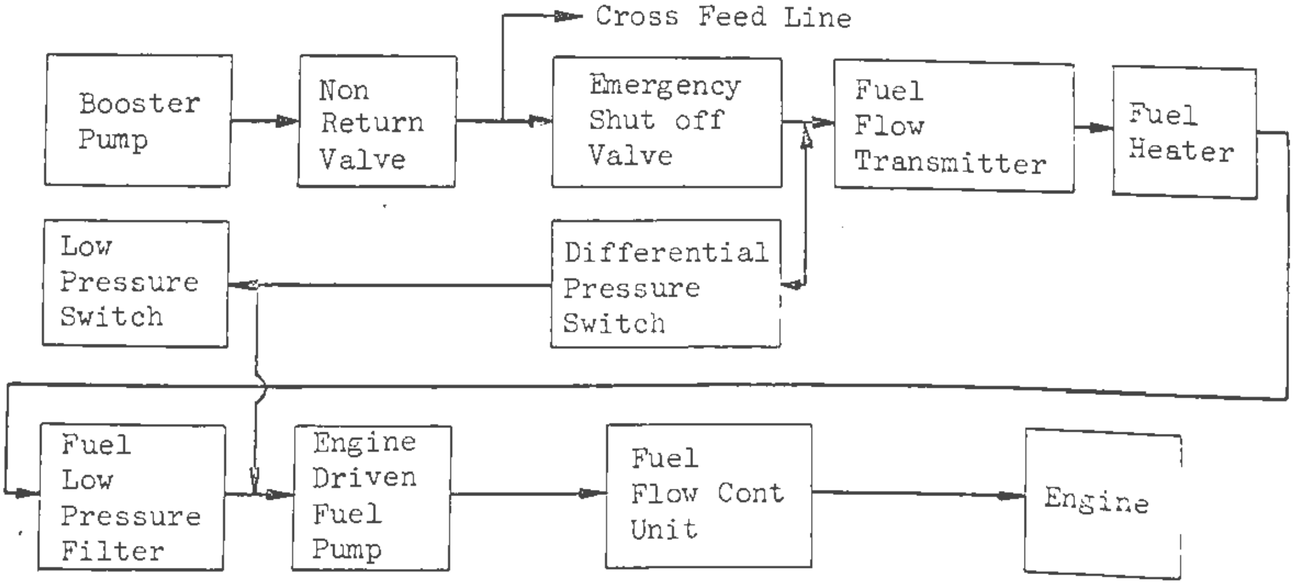
The fuel feed line consists of normal line and cross feed line.

Normal line is routed from the left-hand side tank to the left-hand engine, and from the right-hand side tank to the right-hand engine.

Cross feed line can feed the fuel from left-hand side tank to right-hand side engine and left-hand side engine as well, and from right-hand side tank to left-hand side engine and right-hand side engine as well. That is to say, cross feed lines extend from the fuel tank in either side to both engines.

5.4.1 Normal Feed Line (See Figs. 5-1 and 5-11)

The right-hand and left-hand side normal feed lines are symmetrical. In the collector tank are installed two submerged type booster pumps, one for normal fuel feeding and the other for emergency use. These two pumps are of the same type and same capacity.



Normal Feed Line Diagram

Fuel delivered under pressure from the booster pump is fed to the engine through the route as shown in Fig. 5-1.

This normal feed line is provided with the fuel de-icing system for the prevention of icing of the low pressure filter. The fuel flow transmitter has a built-in by-pass line and this normal feed line has no by-pass line. This feed line has following two pressure switches for sensing any abnormality taking place in the line.

(1) Fuel Low Pressure Switch

(2) Differential Pressure Switch

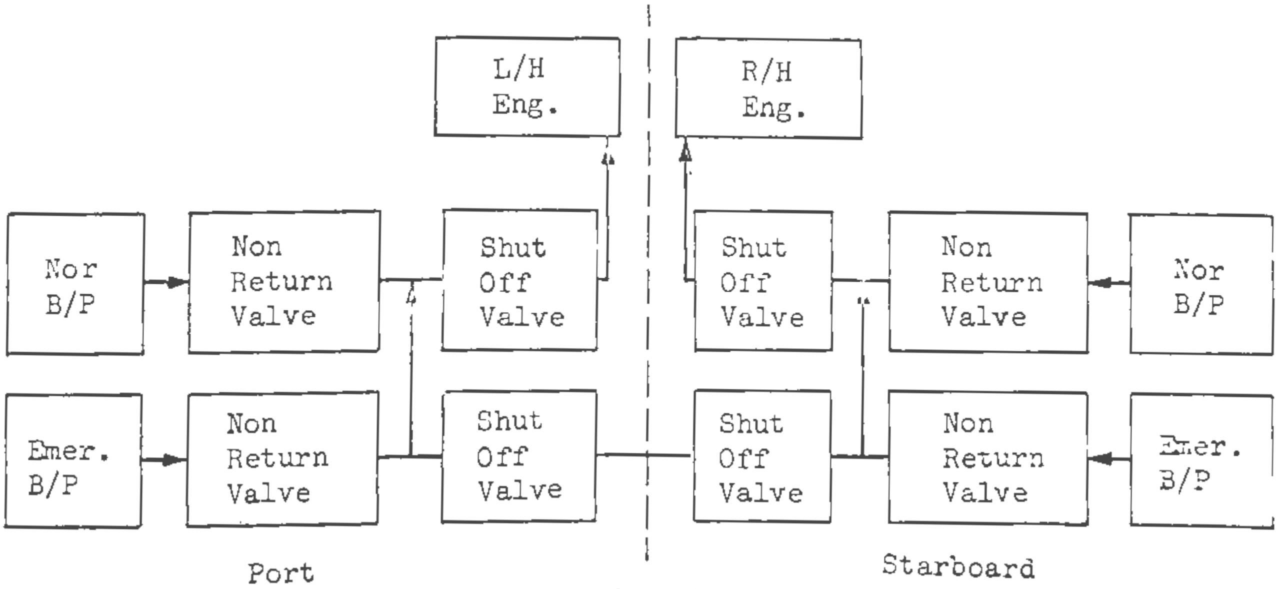
(1) Fuel low pressure switch senses pressure at outlet of low pressure filter. Fuel low pressure switch is so designed as to close the contact point when the fuel line pressure drops below 9 ± 0.25 psi, lighting the warning light (red) located on the shoulder of the fuel flow indicator on the engine instrument panel in the cockpit. Warning light goes out just before the line pressure reaches 10 psi.

(2) Differential pressure switch senses pressure difference between the upstream and downstream of low pressure filter. When difference in pressures exceeds 3 ± 0.2 psi, fuel de-icing warning light (red) comes on. The details will be described in the section of Fuel De-icing System.

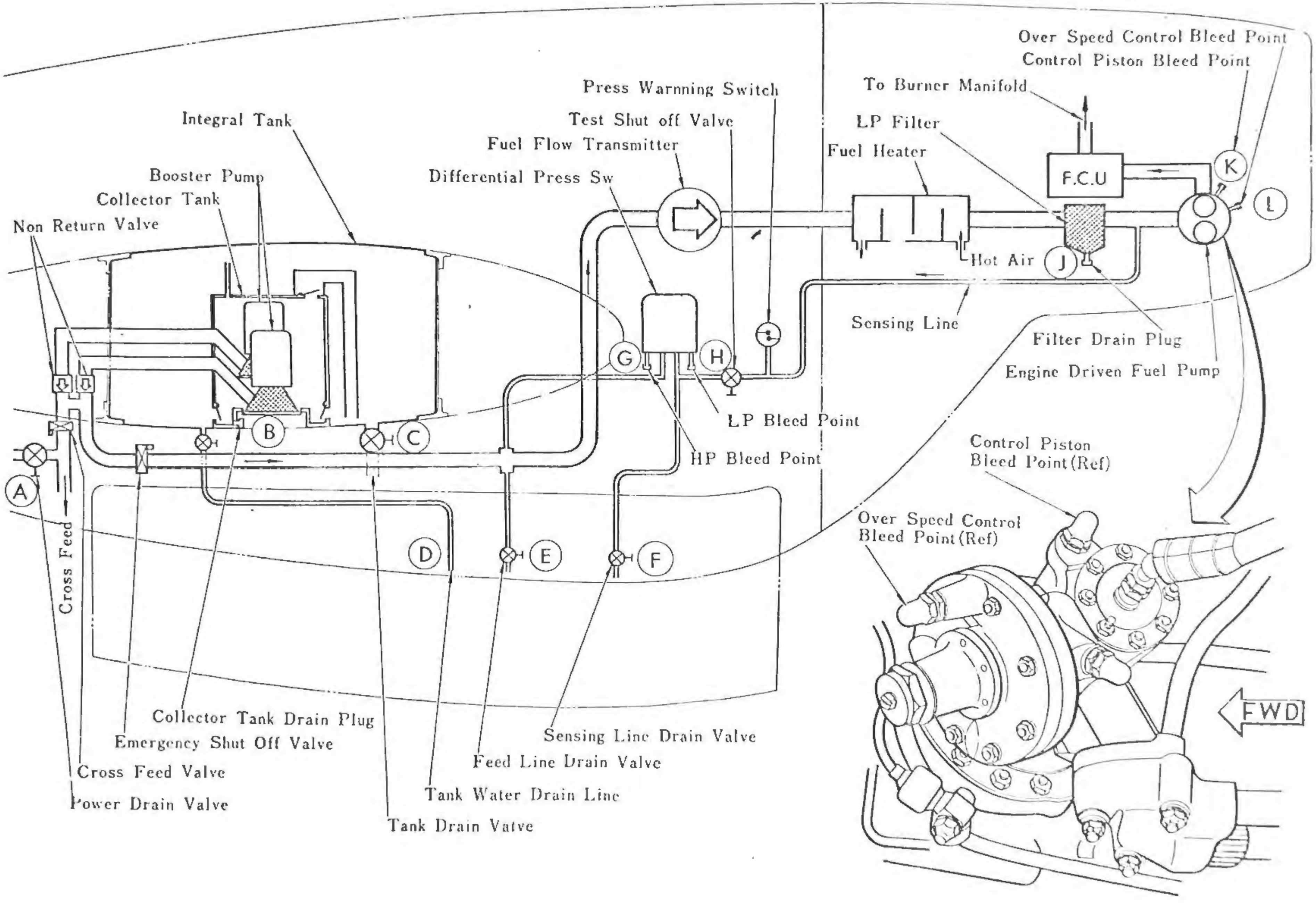
5.4.2 Cross Feed Line (See Fig. 5-1 and 5-12)

The fuel feed line is branched off into two lines at the outlet of the non-return valve of normal line, one is the normal line described above and the other is the cross feed line.

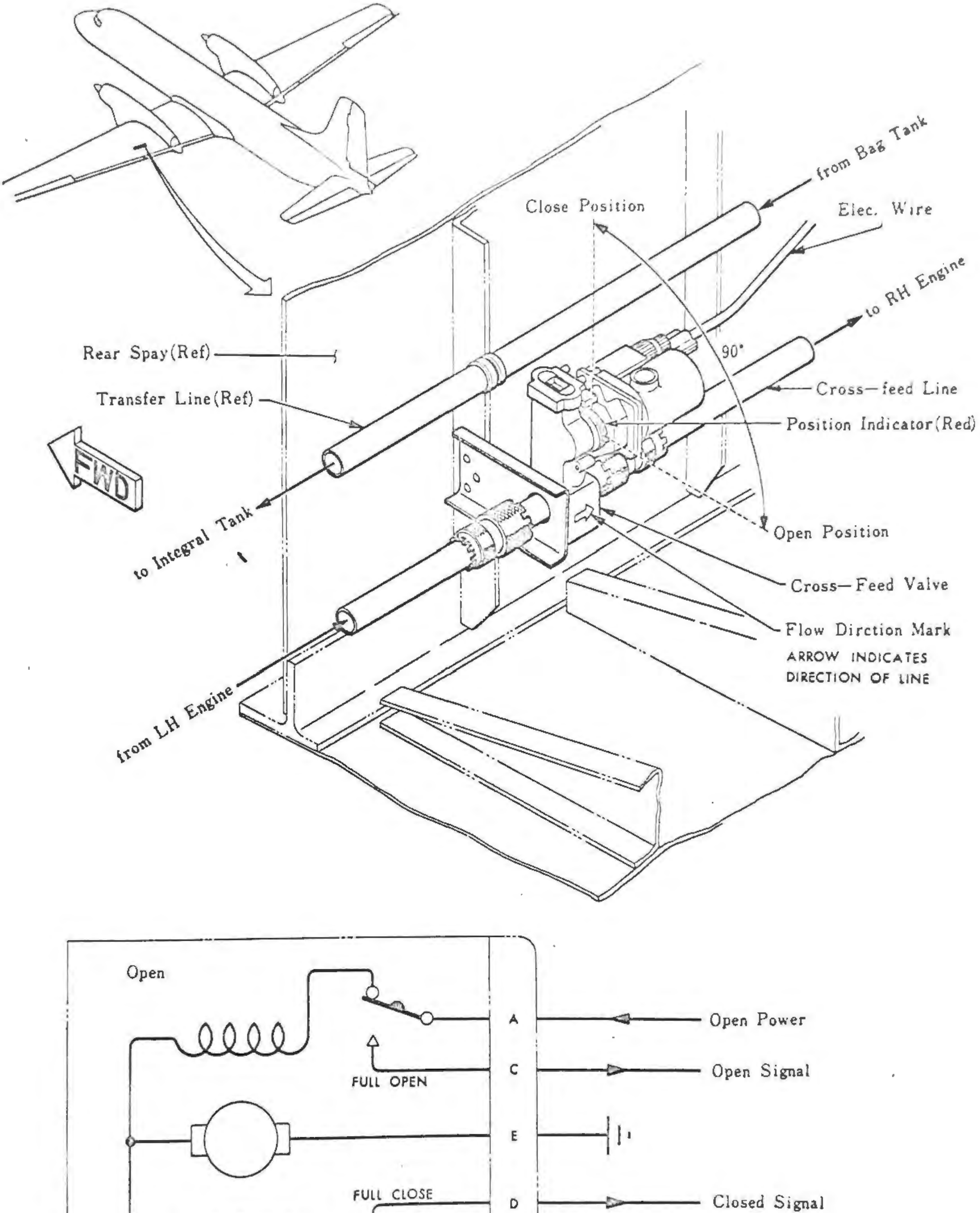
An electrically operated shut-off valve is provided for each of the right and left boards in cross feed line. Turn the cross feed switch in cockpit "ON," then the cross feed valve is opened to cross feed the fuel. During cross feed (electrically operated shut-off valve - OPEN), the valve position indicator indicates "OPEN."



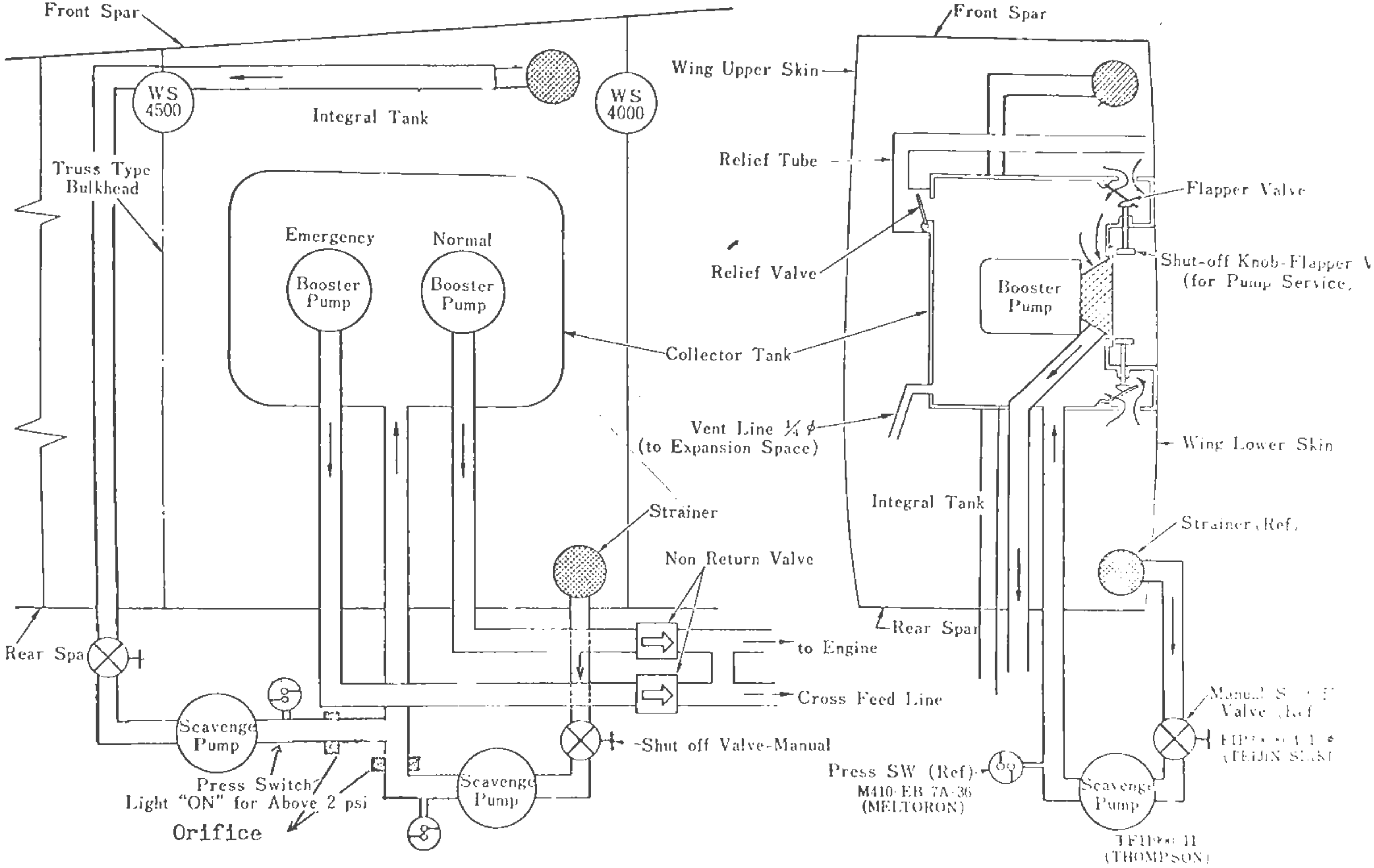
Cross Feed Line Diagram



Feed System Block Diagram
Figure 5-11



Cross Feed Valve Installation
Figure 5–12

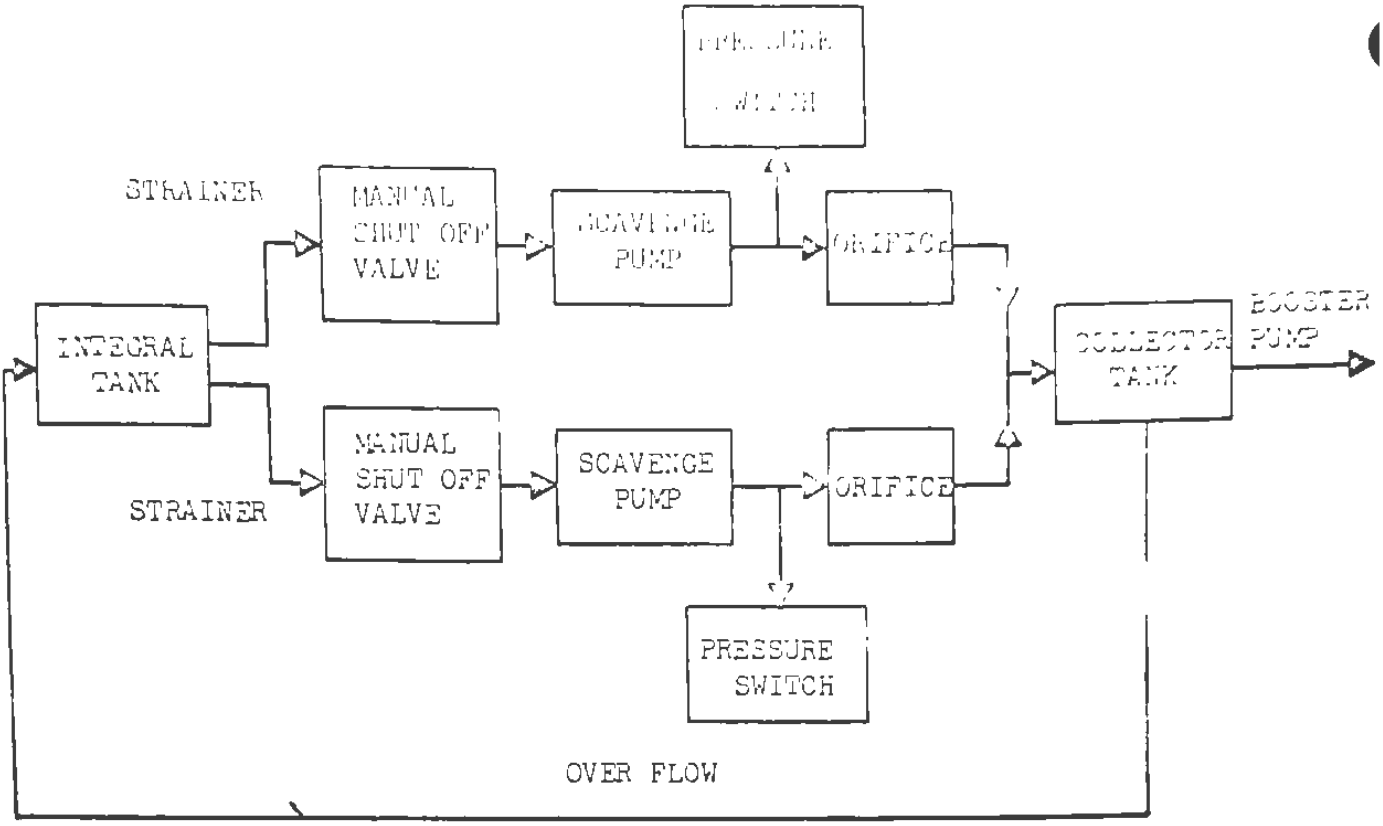


LH Collector Tank Looking from Upper

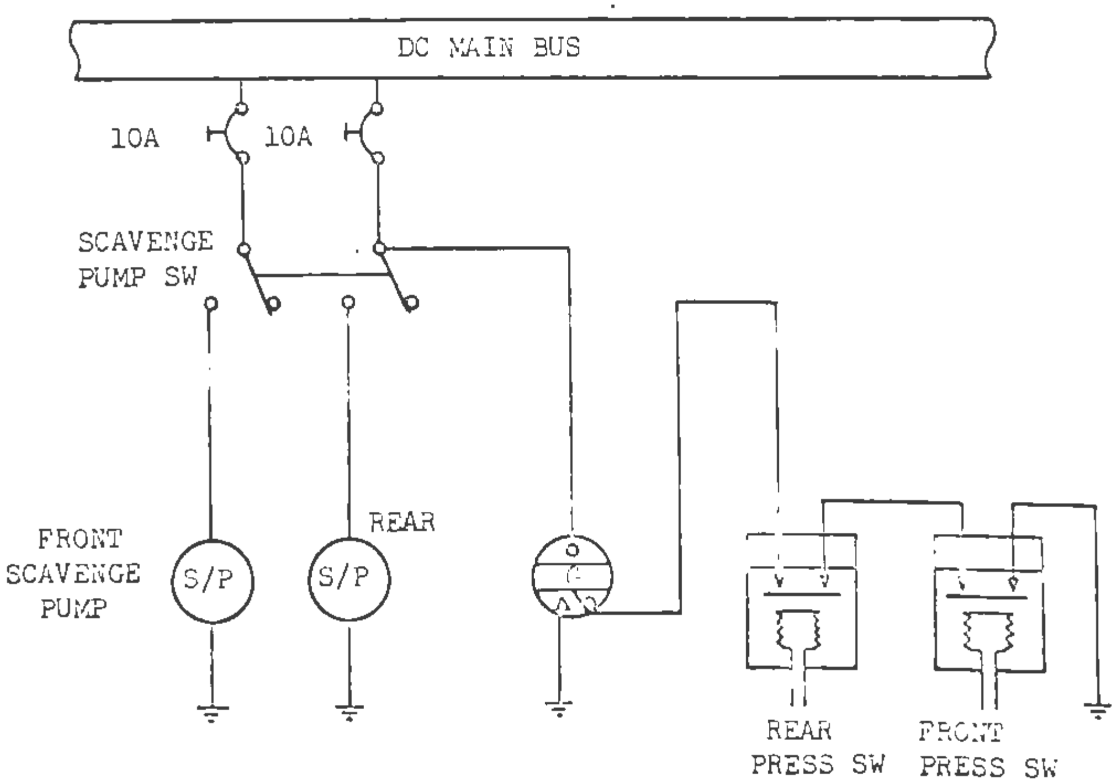
Cross Section View Looking from Inboard to Outboard

Fuel Collector Tank Schematic
Figure 5-13

Reserved



Scavenge Line Schematic



Scavenge Electric Schematic

Figure 5-13A

5.4.3 Scavenge System (See Fig. 5-13)

Each wing is provided with two scavenge pumps and the strainers between the front and rear spars. These two pumps are operated simultaneously. The duty of this scavenge system is to minimize the unusable quantity of fuel in the tank. When the fuel level in the tank has dropped, the scavenge pump, which is a kind of vane type pump, installed on the flap well outside the tank, transfers fuel in the tank to the collector tank.

The pressure switch is provided for sensing scavenge pump delivery pressure to indicate the operating condition of the scavenge system. When the pump is in operation (line pressure is over 2.5 psi), the scavenge pump indicating light (green) on the instrument panel in the cockpit comes on. The indicating light goes out if the pressure in line drops below 2.0 ± 0.25 psi.

5.4.4 Fuel System - Operation

The fuel system control panel is located on the overhead panel in the cockpit. The electrically-operated shut-off valve, pumps, etc. in the system are operated by switches on this panel.

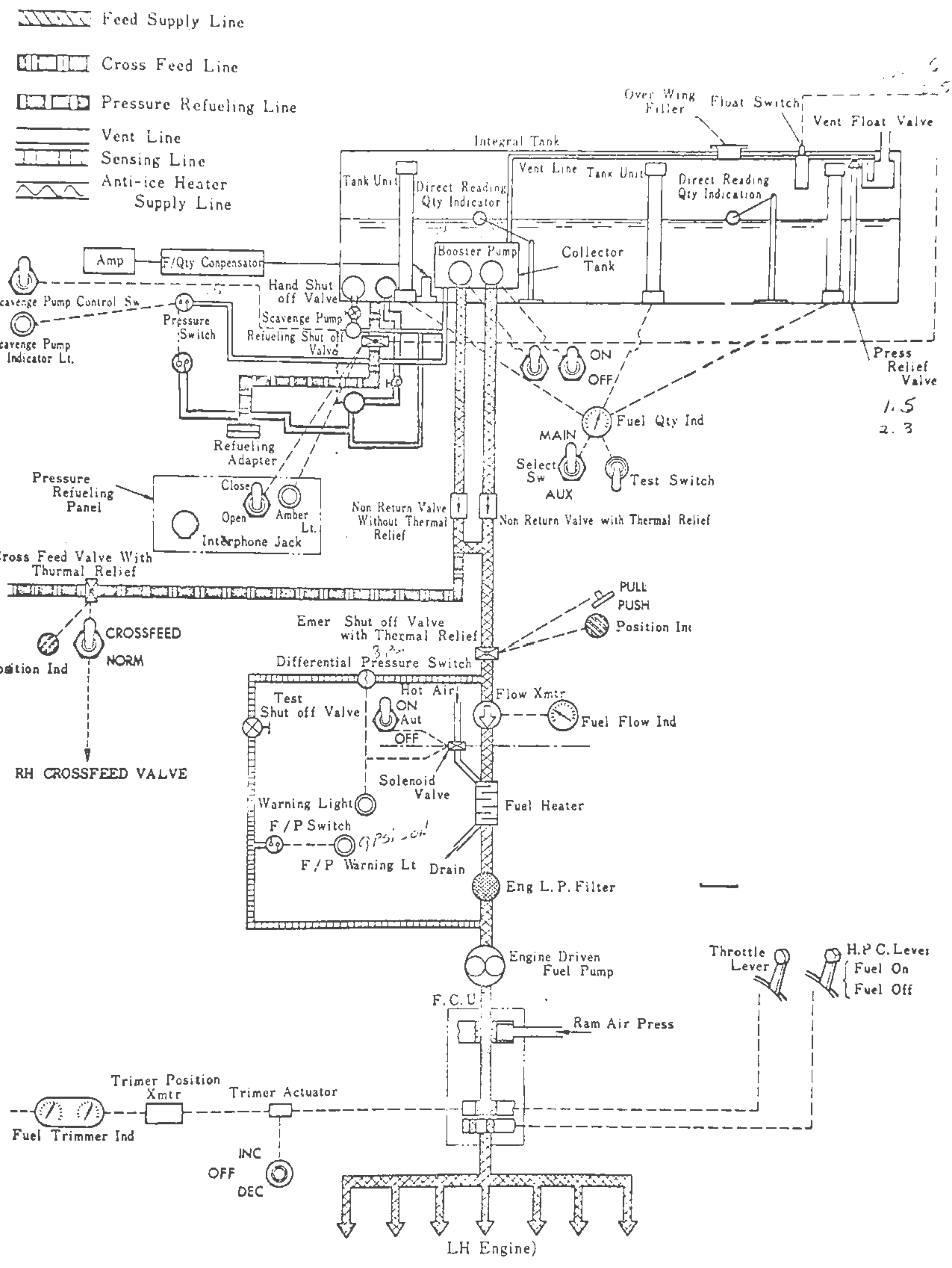
5.5 Construction and Functions of Fuel Feed System Components

Under all expected flight conditions, the system always is capable of supplying sufficient fuel flow with necessary fuel pressure to the engines. Some examples are explained as follows.

Take-off Period: Two booster pumps, one for normal operation and the other for emergency, are installed in collector tank of each side of the wing and supplies sufficient quantity of fuel.

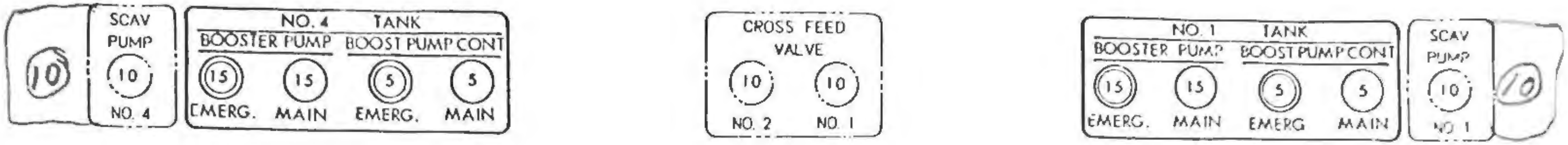
Negative Gravity Period: The system continues to feed fuel for 5 seconds (as expected from the construction of the collector tank).

Maximum Climb or Descent Attitude: A scavenge pump is provided to cope with centering of fuel to extremity when the aircraft takes this attitude.

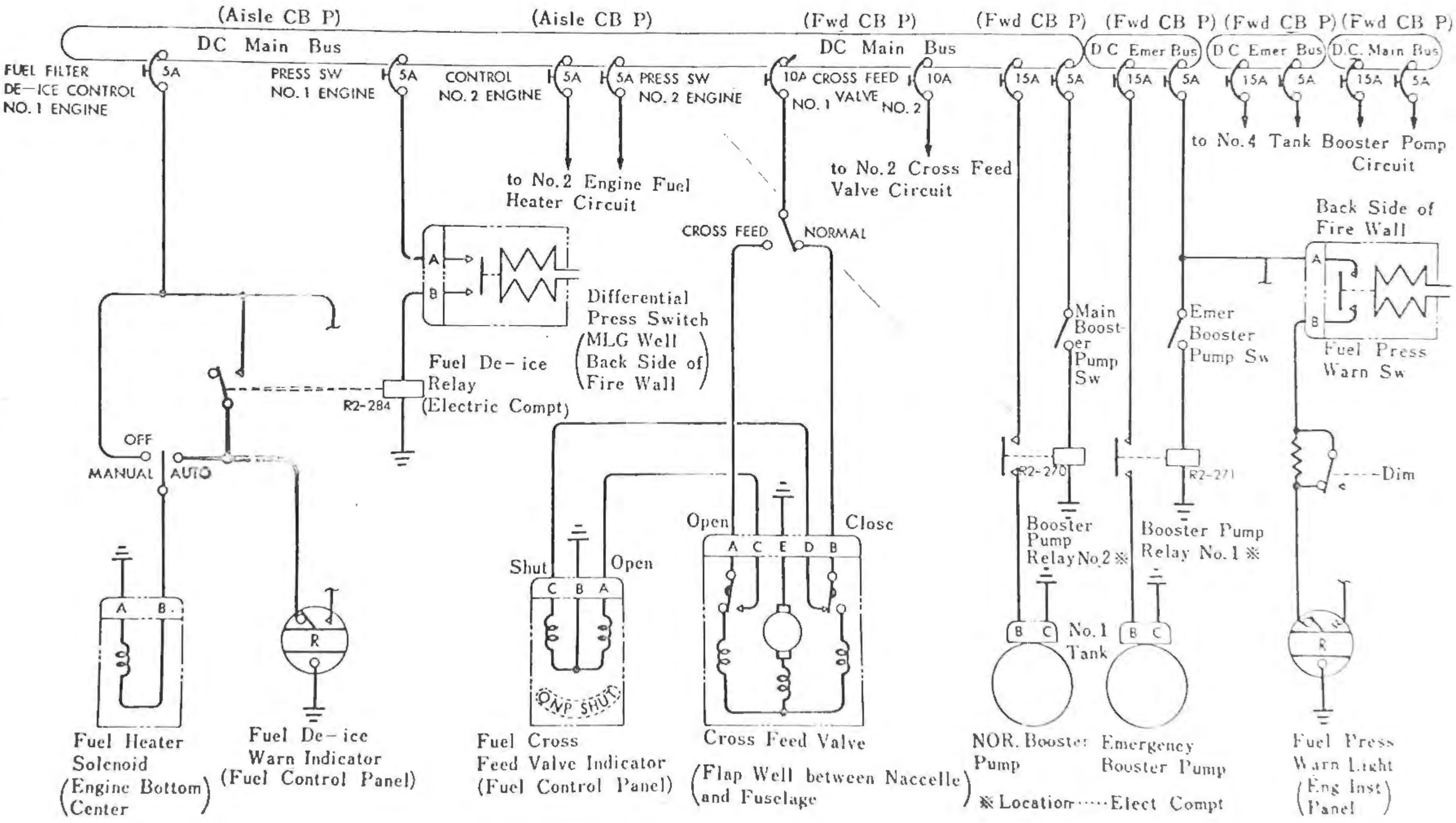


Fuel System Control Diagram

Figure 5–15



Fwd CB Panel



Fuel System Electrical Schematic
Figure 5-16

Deleted

Figure 5-17

Bank Attitude: To cope with centering of fuel to extreme position due to this attitude, the counter-flow preventing partition and the collector tank are provided.

Outside Air Temperature: Between -55°C and +57°C, the system can fully accomplish its function. For fuel de-icing and the escapement of pressure due to a temperature expansion in the sealed lines, the emergency shut-off valve, cross feed valve, non-return valve etc. are provided.

5.5.1 Feed Line Piping

The feed line piping installed on the rearward side of the main wing rear spar is made of aluminum alloy and that installed between the main landing gear well and the engine is made of stainless steel.

Pipe sizes are as follows:

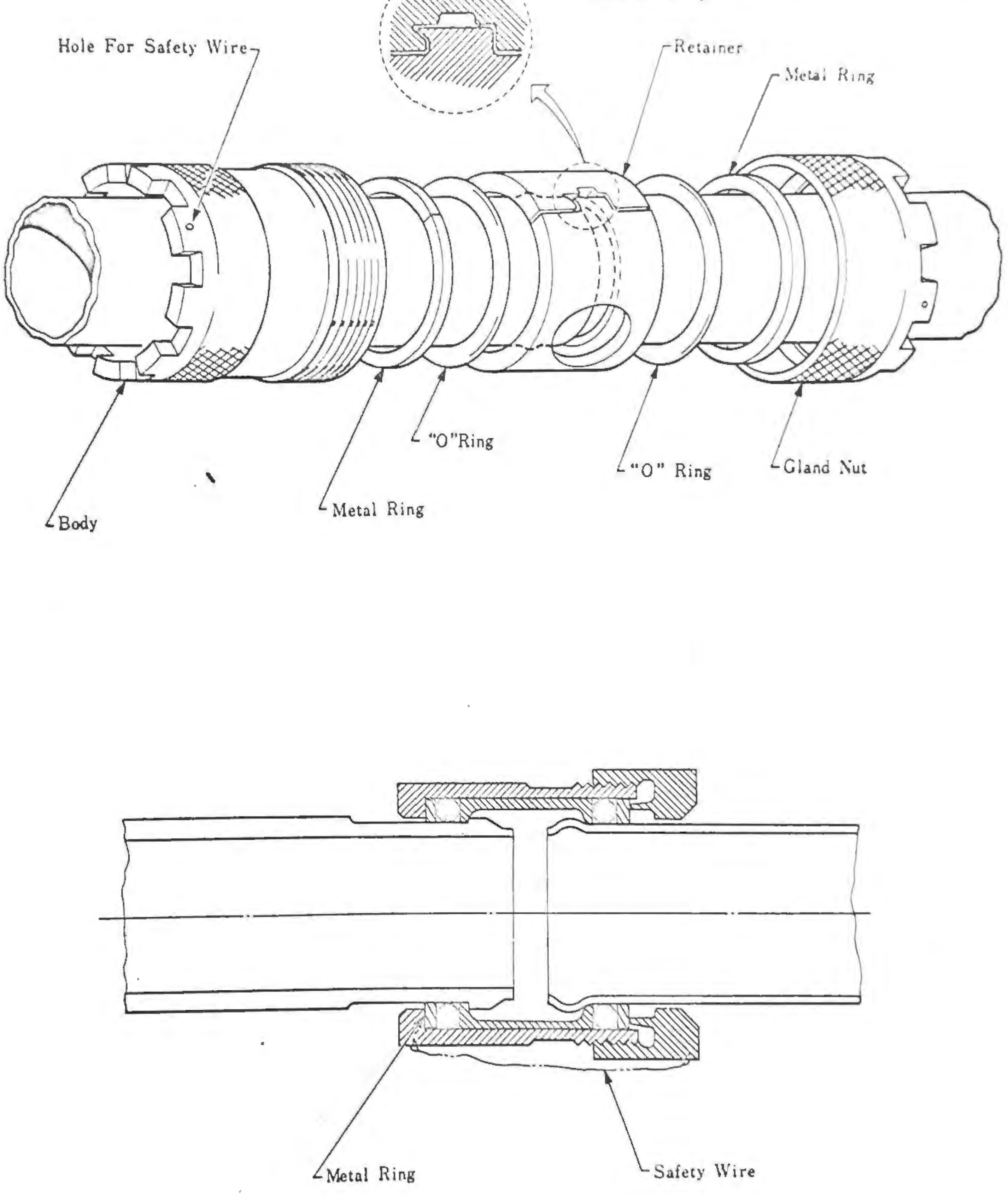
Engine Feed and Cross Feed Line	1 inch dia.
Scavenge Line	1 inch dia.
Pressure Refueling Line	1-1/2 or 1 inch dia.
Vent Line (Integral and Bag Tank)	1 or 1/2 inch dia.
Vent Line (Collector Tank)	1/4 inch dia.
Anti-icing Heater	3/8 inch dia.
Sensing Line	1/4 inch dia.
Transfer Line	1 inch dia.

As pipe coupling, AN coupling and flexible coupling are used. The former is employed for connecting pipes on the tank wall. The latter comprises wiggings flexible coupling and marman flexible coupling. Employed in the largest number is wiggings flexible coupling, which is designed to be bent in accordance with the deflection of the wing.

At the engine fire wall, the quick disconnect coupling is used to facilitate engine change.

The pipe coupling in use on the tank wall is a fitting with male thread (AN coupling) on both sides of the round corner. The collar is riveted to the tank wall after face sealing treatment.

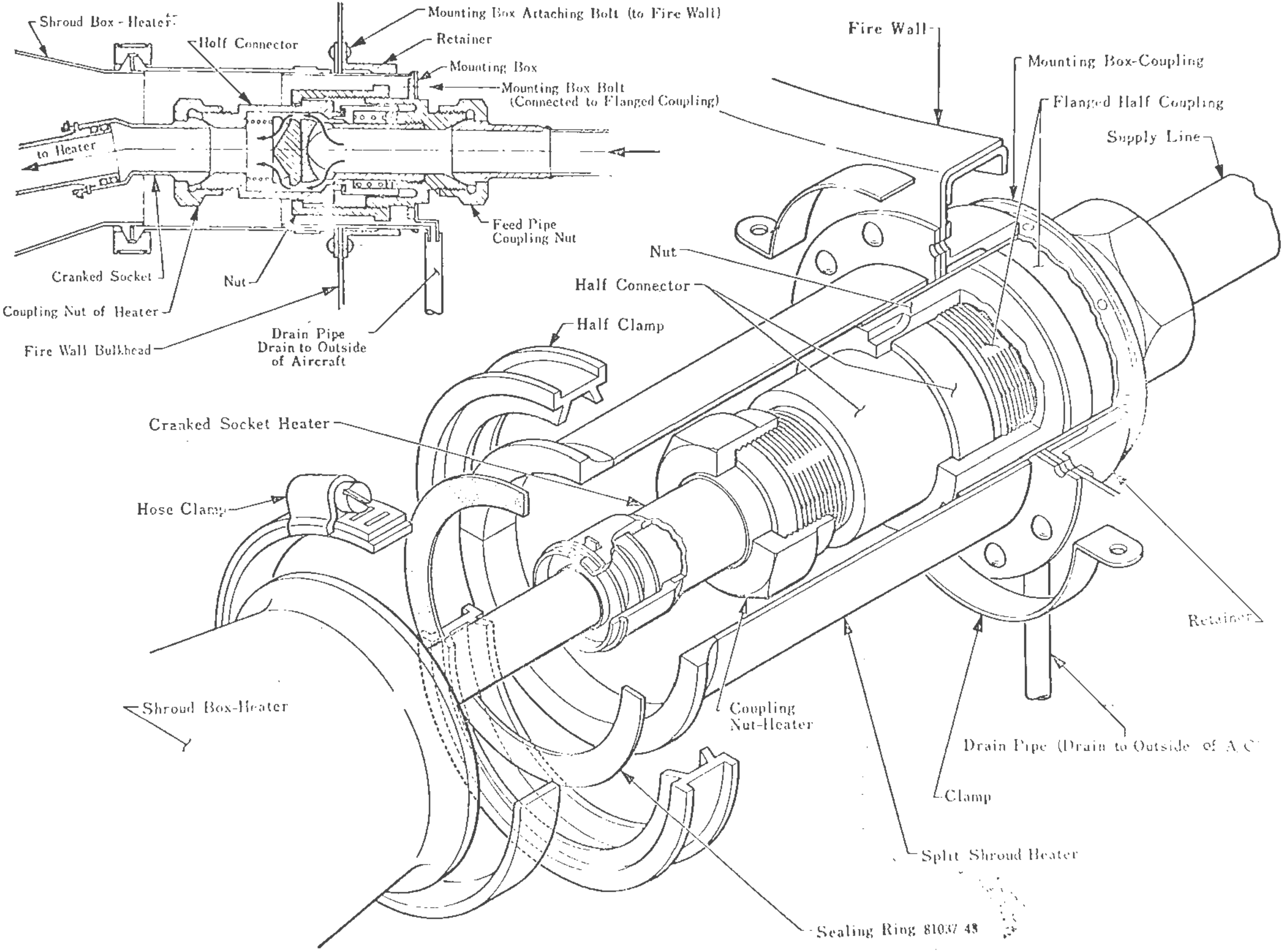
Pipe couplings installed inside the fuselage are confined in shrouds which lead fuel leaks at the coupling outside aircraft through their drain pipes.



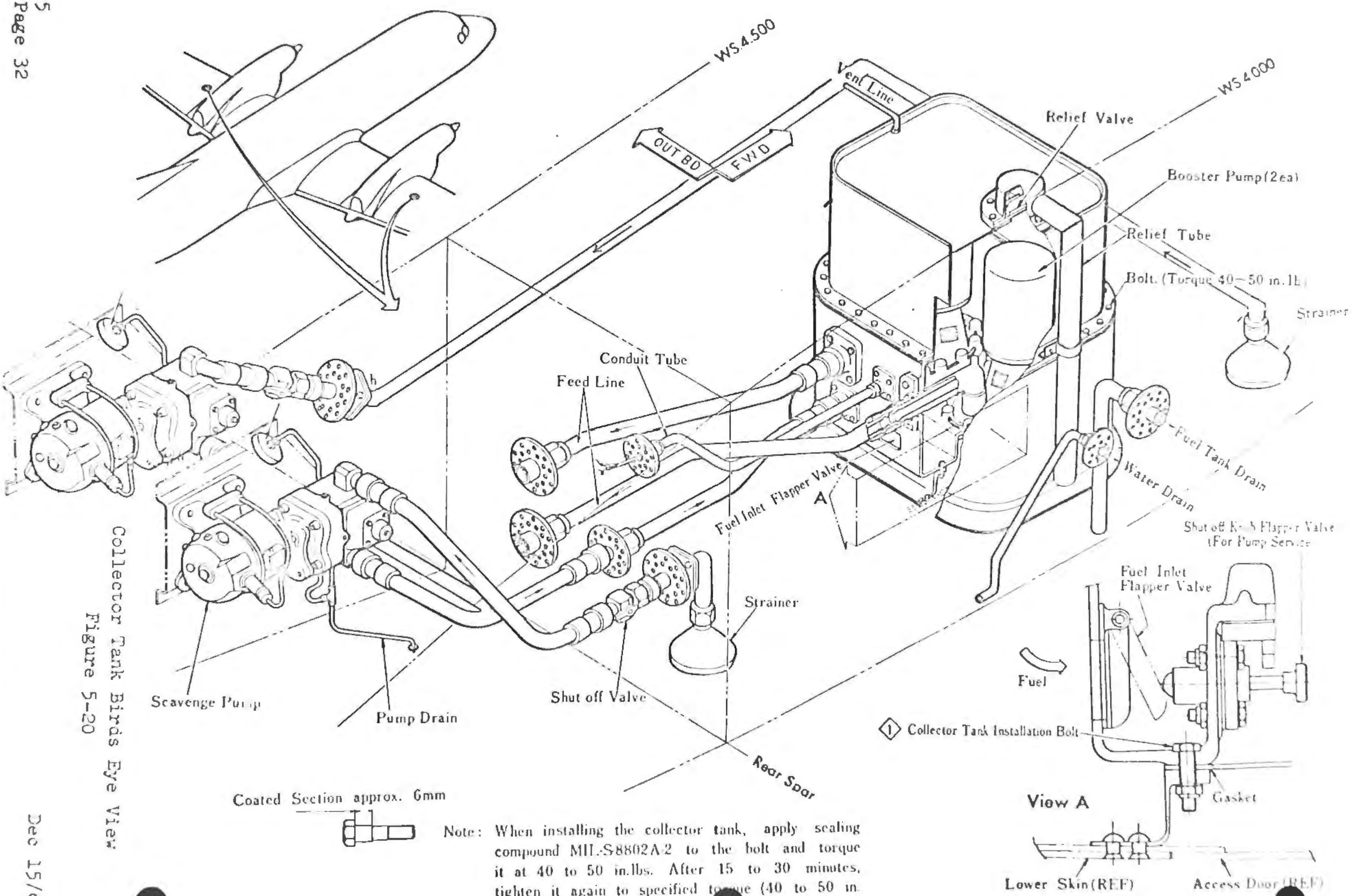
Note: To remore the upper section from the lower section, first slide the upper section towards you and then lift it up.

Wiggins Flexible Coupling

Figure 5–18

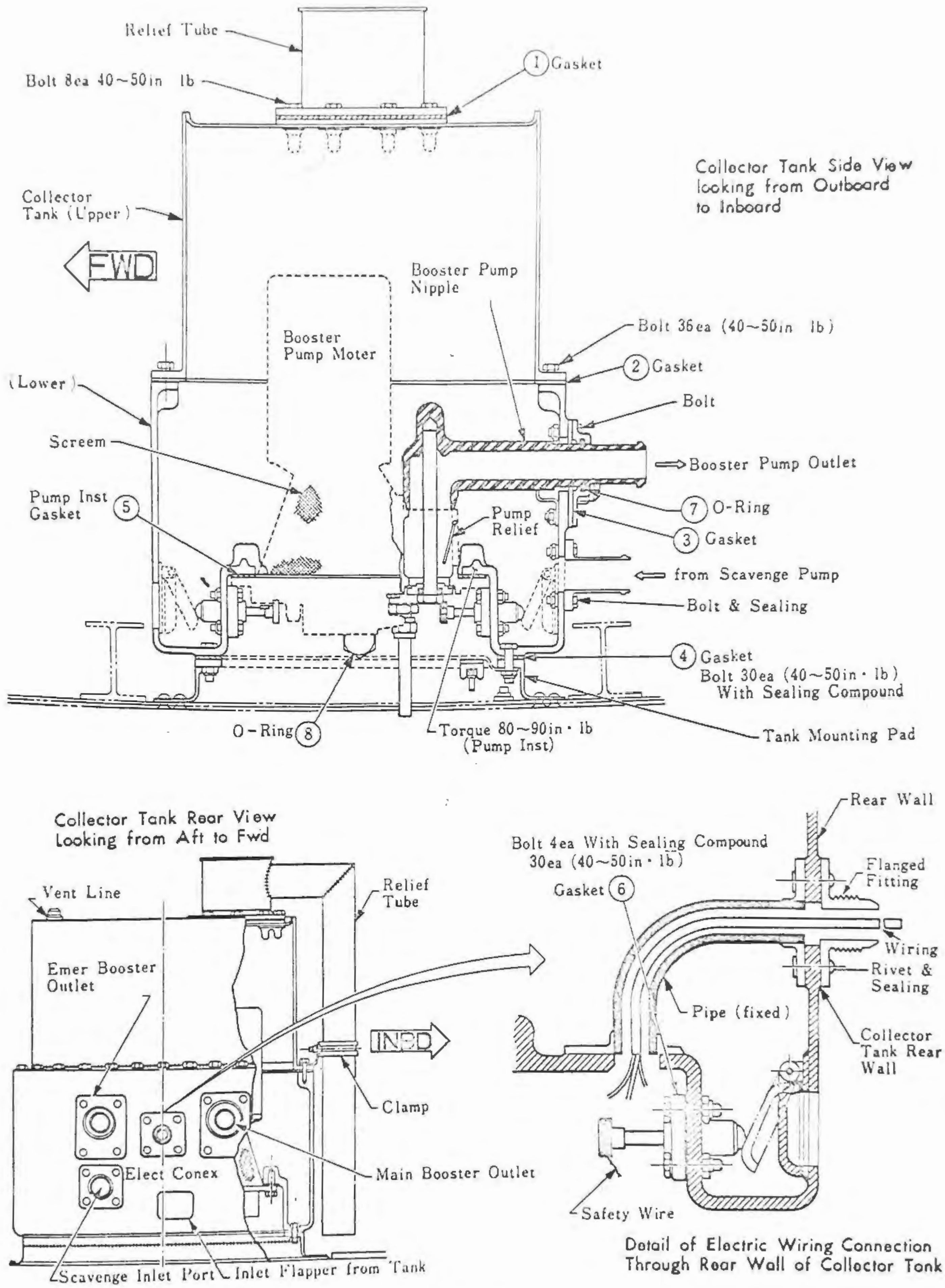


Fire Wall Fuel Line Self Sealing Coupling Installation
Figure 5-19



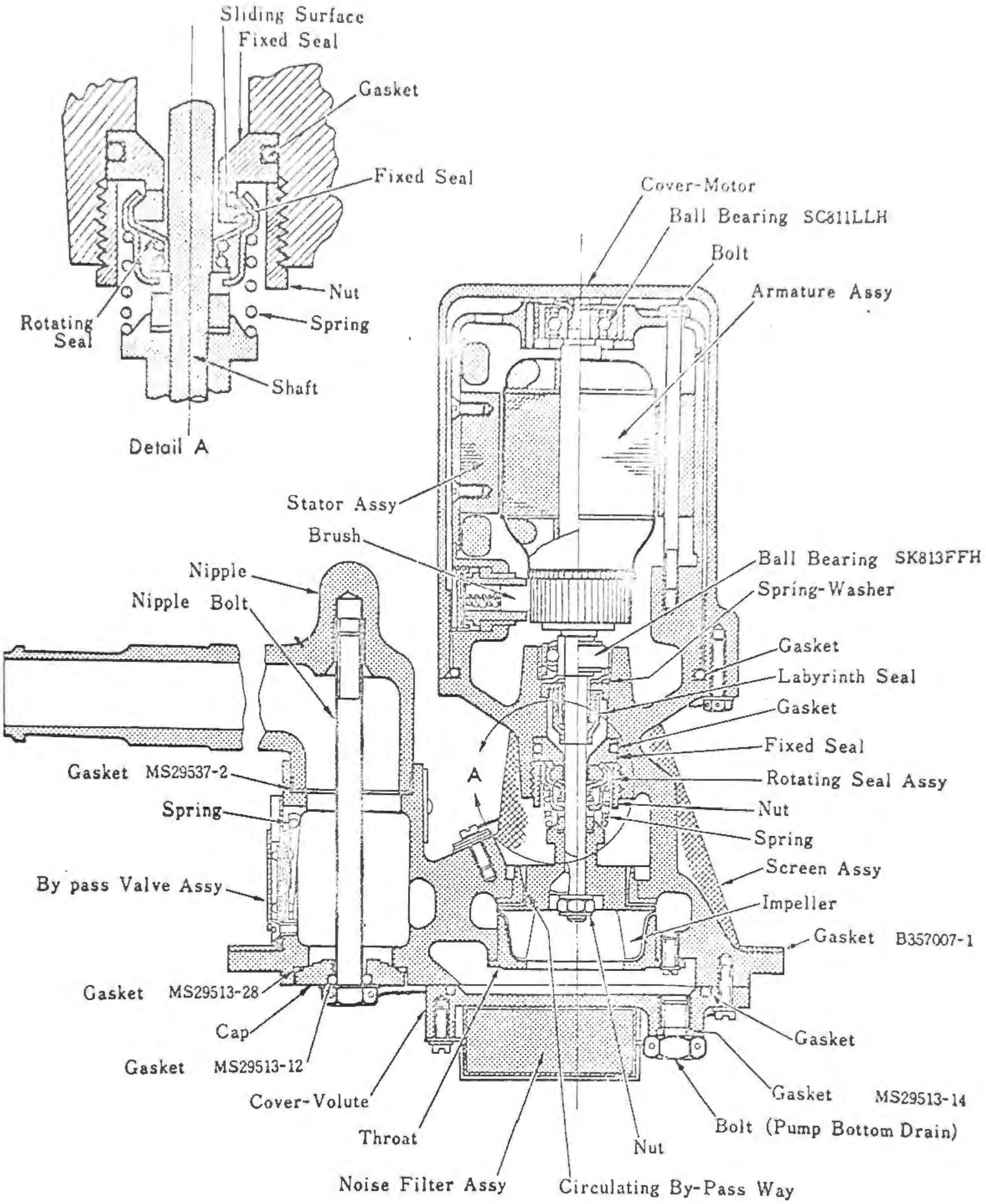
Collector Tank Birds Eye View
Figure 5-20

Note: When installing the collector tank, apply sealing compound MIL-S8802A-2 to the bolt and torque it at 40 to 50 in.lbs. After 15 to 30 minutes, tighten it again to specified torque (40 to 50 in. lbs.)



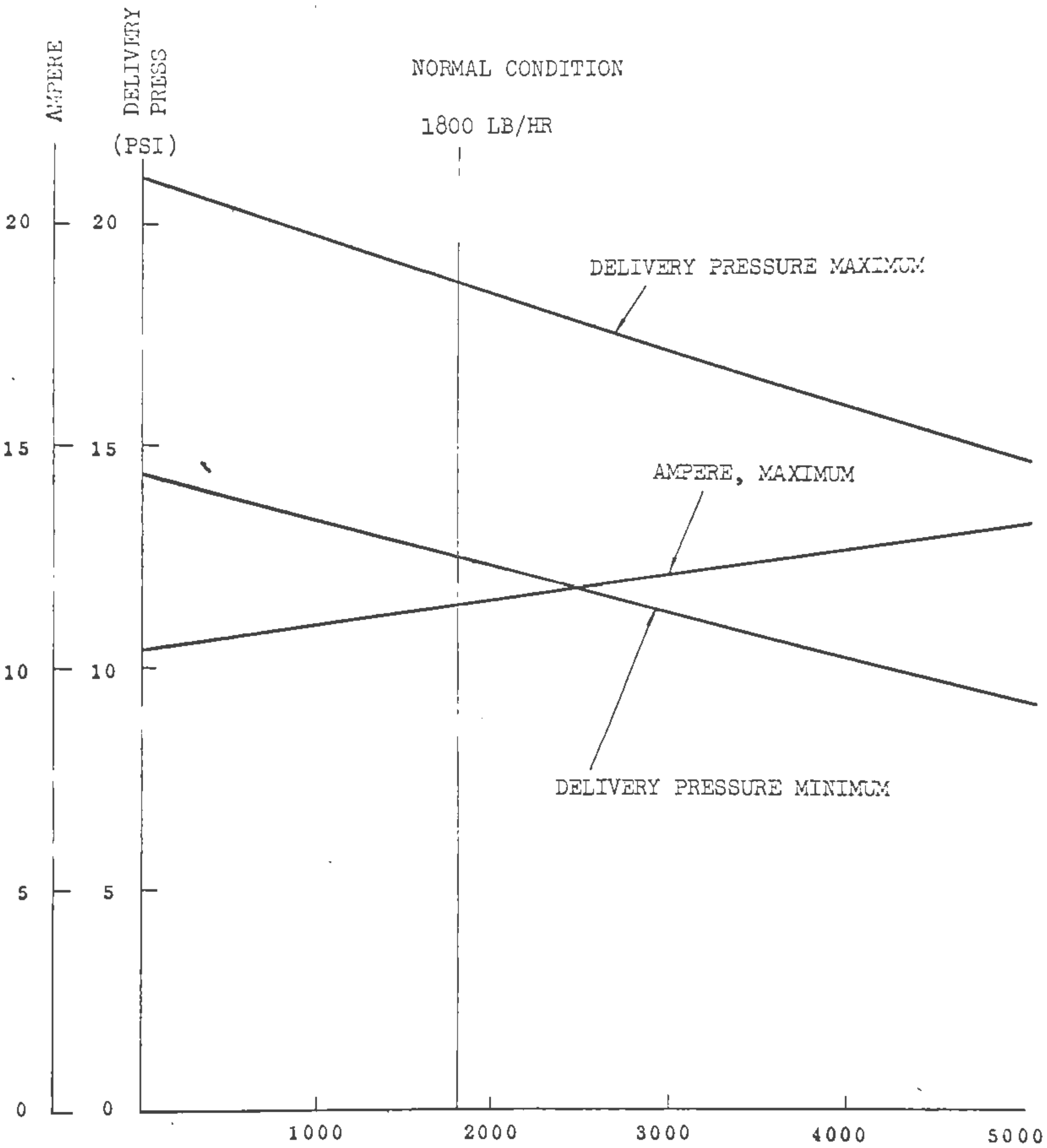
Collector Tank Installation

Figure 5–21



Section View of Booster Pump

Figure 5-22



FUEL BOOSTER PUMP PERFORMANCE REQUIREMENT

Figure 5-23

5.5.4 Non-Return Valve (See Fig. 5-25)

The non-return valves are installed in normal feed line, cross feed line, transfer line, etc. Pressure loss by this valve is very small, 0.5 psi even in flow corresponding to take-off period.

The non-return valve at the outlet of the normal booster pump is provided with a thermal relief hole, but the emergency booster pump has no such a hole. The thermal relief hole has an opening which can allow 40 to 60 cc/min. of fuel flow against a pressure head of 10 psi.

5.5.5 Shut-off Valve (See Fig. 5-26)

Electrically operated and manually operated shut-off valves are used in the system.

Following valves are electrically operated:

Emergency shut-off valve in normal feed line.

Cross feed valve in cross feed line.

Refueling shut-off valve in pressure refueling line.

Following valve is manually operated:

Hand shut-off valve in scavenge line

Thermal relief valves are built in the emergency shut-off valve and the cross feed valve. Outside the valve is fixed a mechanical indicator for the visual confirmation of the valve position (open or close). The body thermal relief valve relieves pressure at 120 psi and the line relief valve at 20 to 45 psi, respectively. Operating time of the valve from the full close to full open position is 0.5 to 1 second at minimum.

5.5.6 Scavenge Pump (See Figs. 5-17 and 5-27)

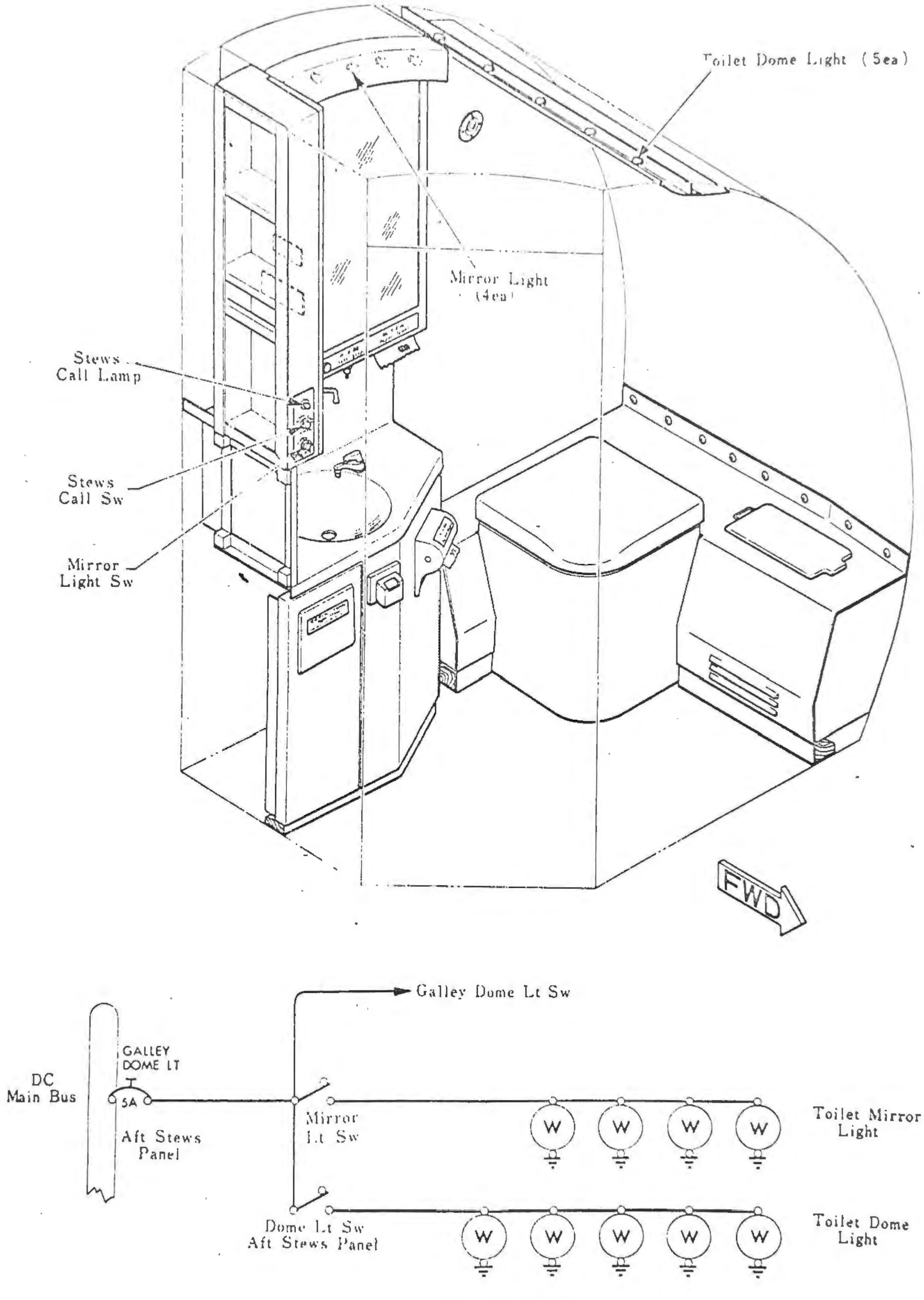
This pump is a vane type pump. Its delivery pressure is adjusted to 3 to 5 psi. The pump motor, a D.C. series motor, is provided with a radio noise filter.

The pump is installed in the flap well of the trailing edge of the wing outside the nacelle. The four pumps have the same functions.

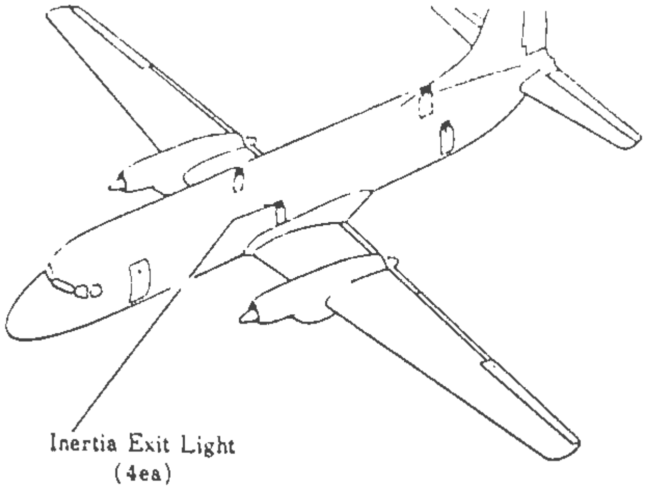
Specifications of the pump is as follows:

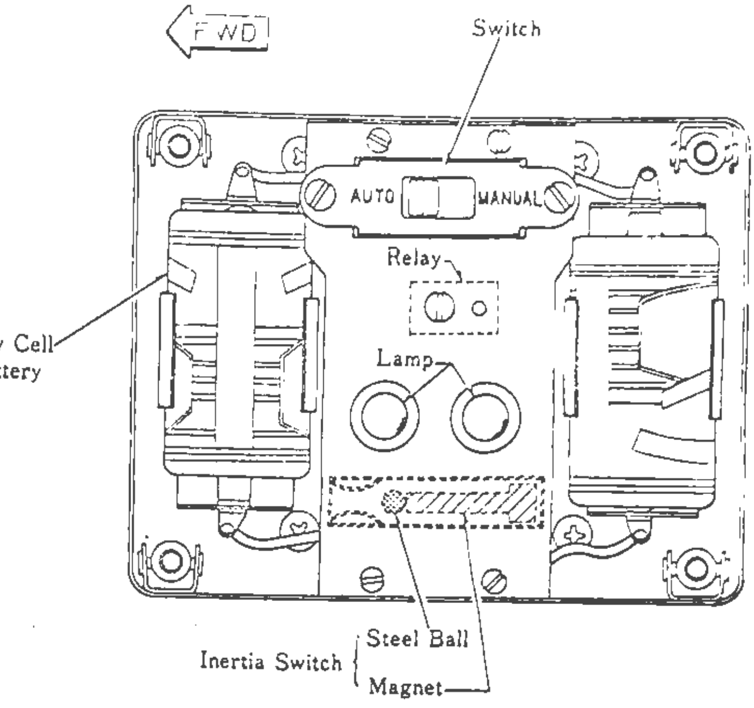
Flow rate	2200 lbs/hr
Delivery pressure	3 to 5 psi
Suction pressure	1.5 m Hg

A scavenge pressure switch which senses scavenge pump fuel pressure is installed in the flap well. The function of the scavenge pressure switch is such that the scavenge indicating light (green) comes on when the pressure exceeds 2 psi and the light goes out when the pressure drops below 2 ± 0.25 psi. Therefore, if the pressure of one pump goes down below 2 psi, both lights go out.

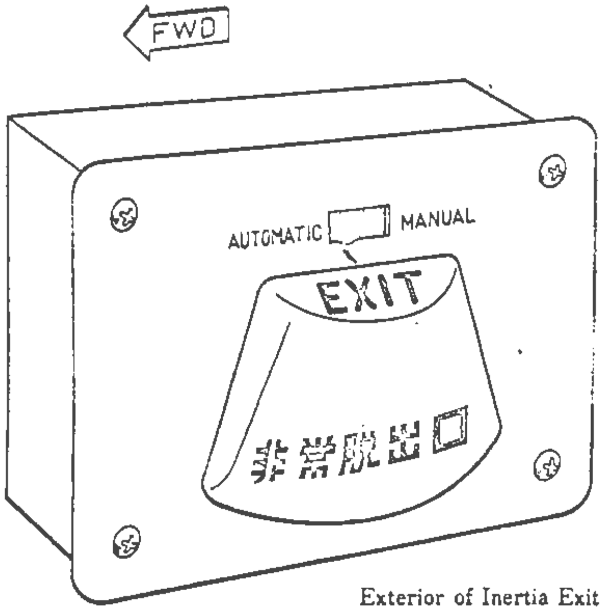


Lavatory Light Arrangement
Figure 9—47

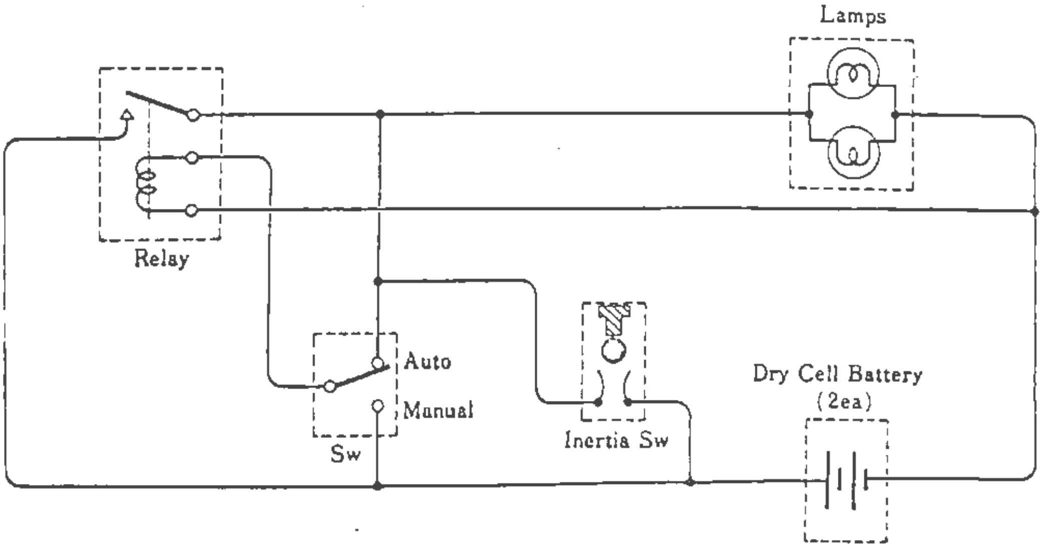




Inertia Exit Light—Cover Removed

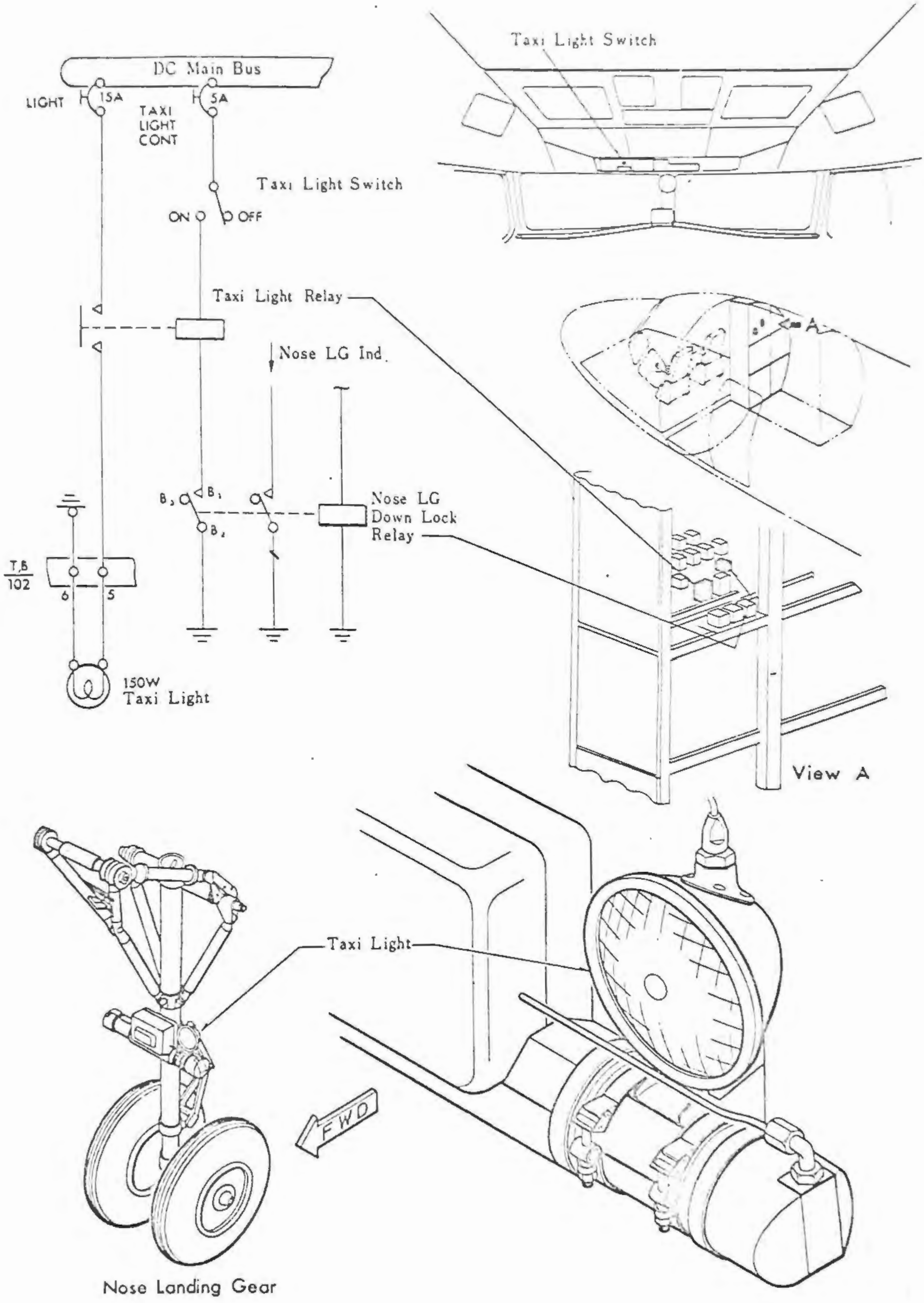


Exterior of Inertia Exit Light

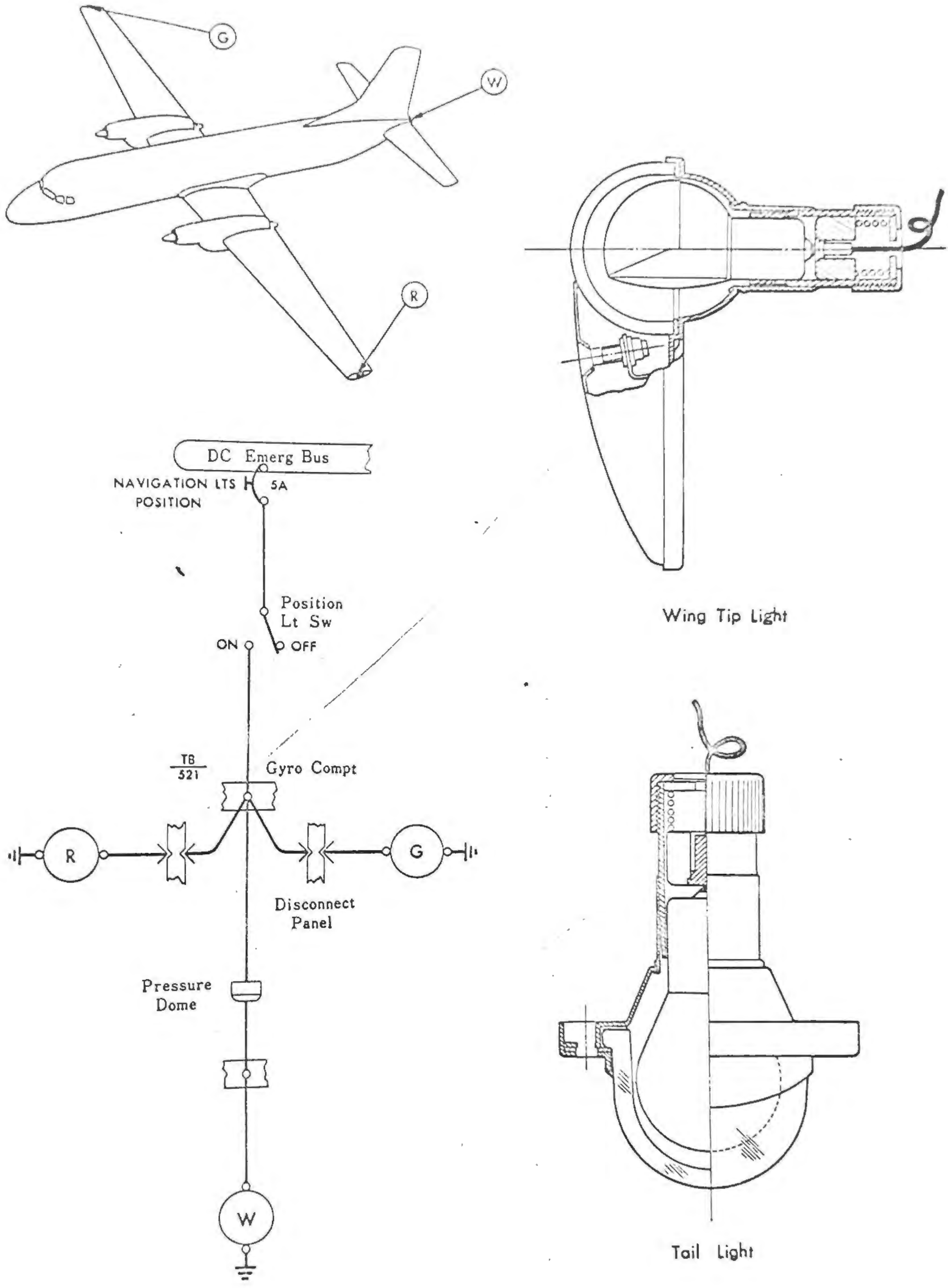


Inertia Exit Light Schematic Wiring

Inertia Exit Light
Figure 9–53



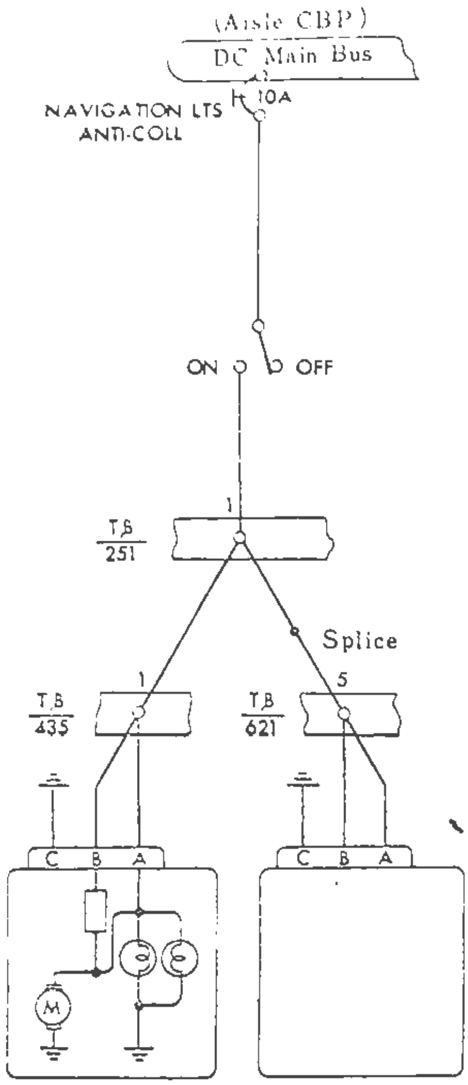
Taxi Light
Figure 9-55



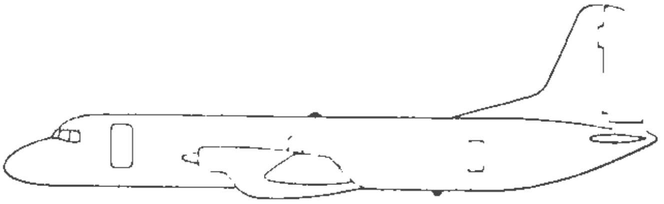
Wing Tip Light

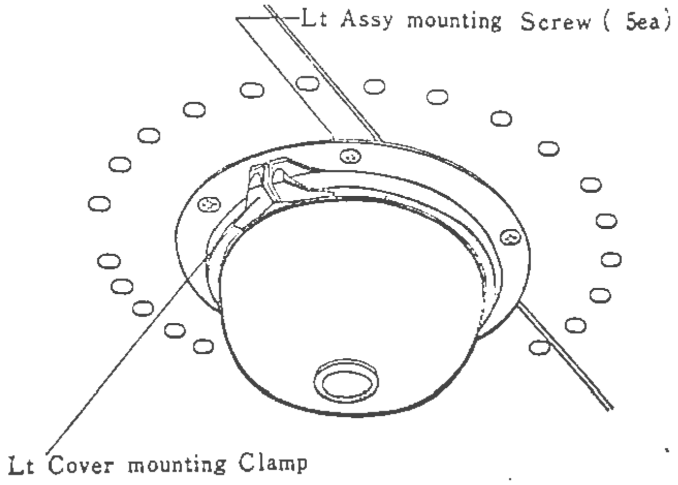
Tail Light

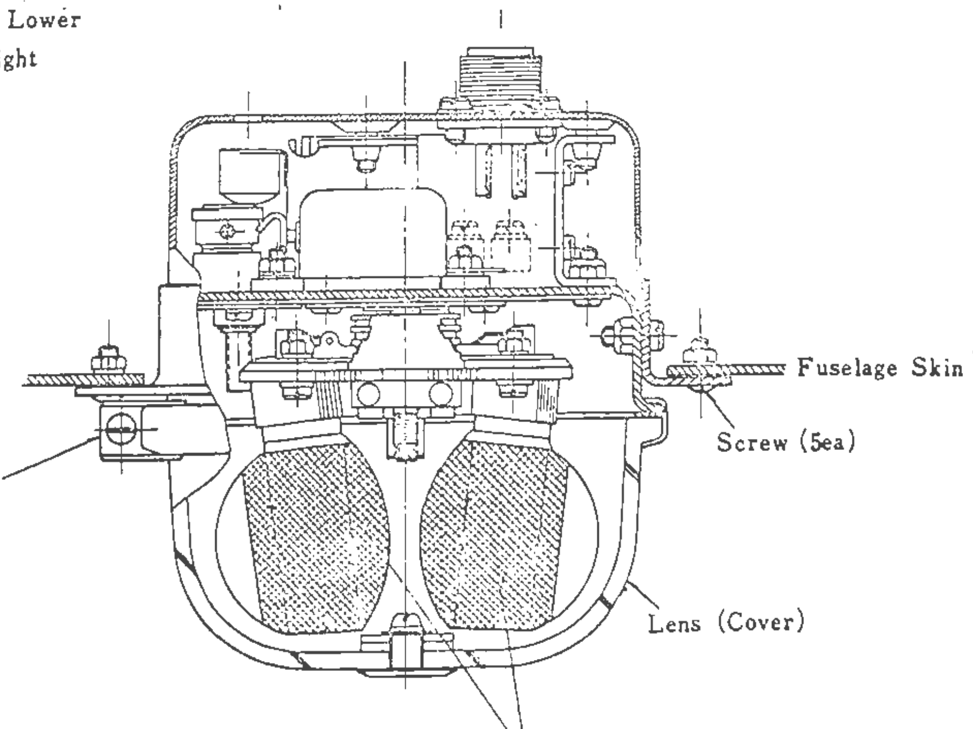
Navigation Light
Figure 9–56



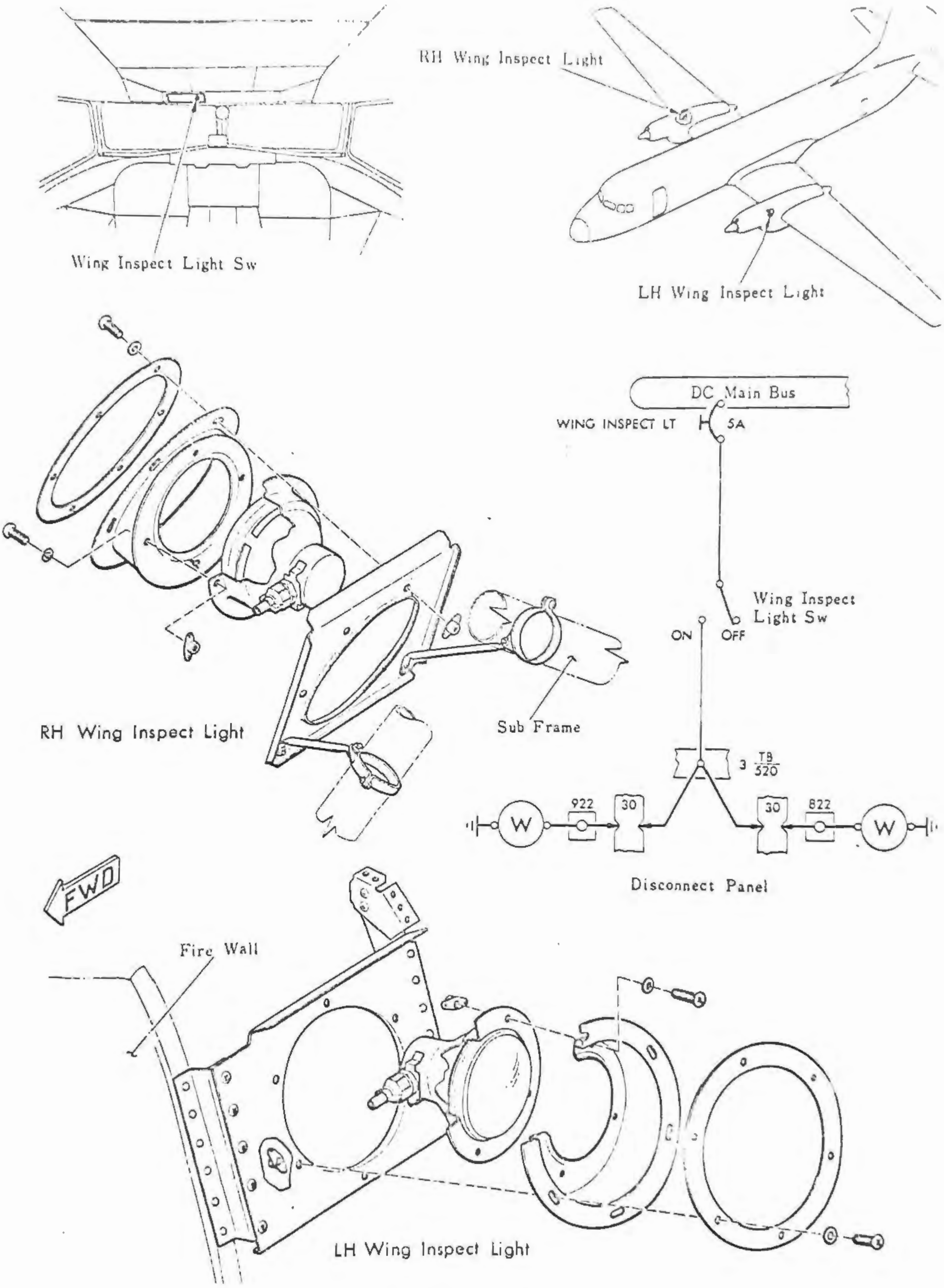
Anti-Collision Light



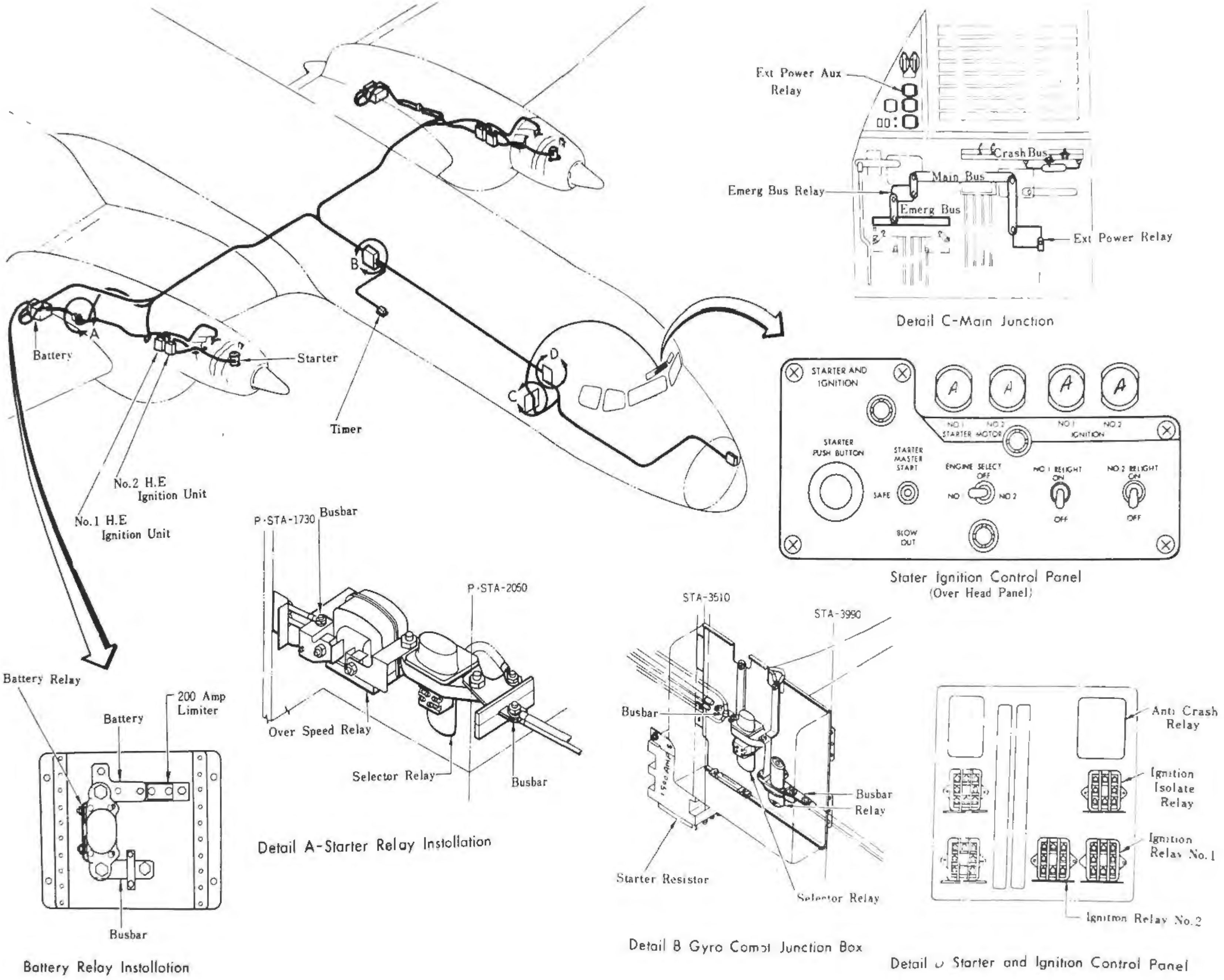




Anti-Collision Light
Figure 9-57



Wing Inspect Light
Figure 9-58



Detail C-Main Junction

Stater Ignition Control Panel
(Over Head Panel)

Detail A-Starter Relay Installation

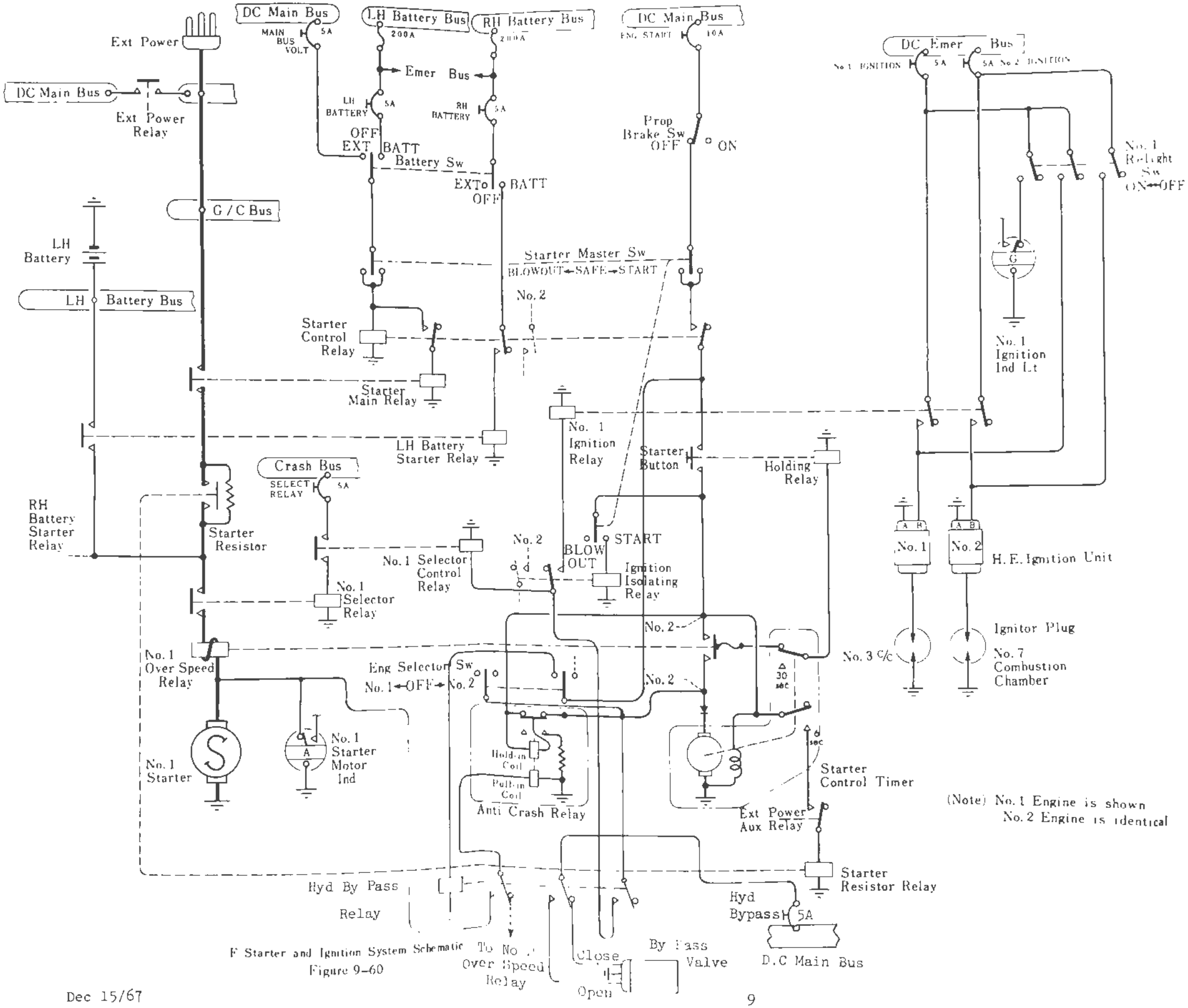
Battery Relay Installation

Detail B Gyro Compt Junction Box

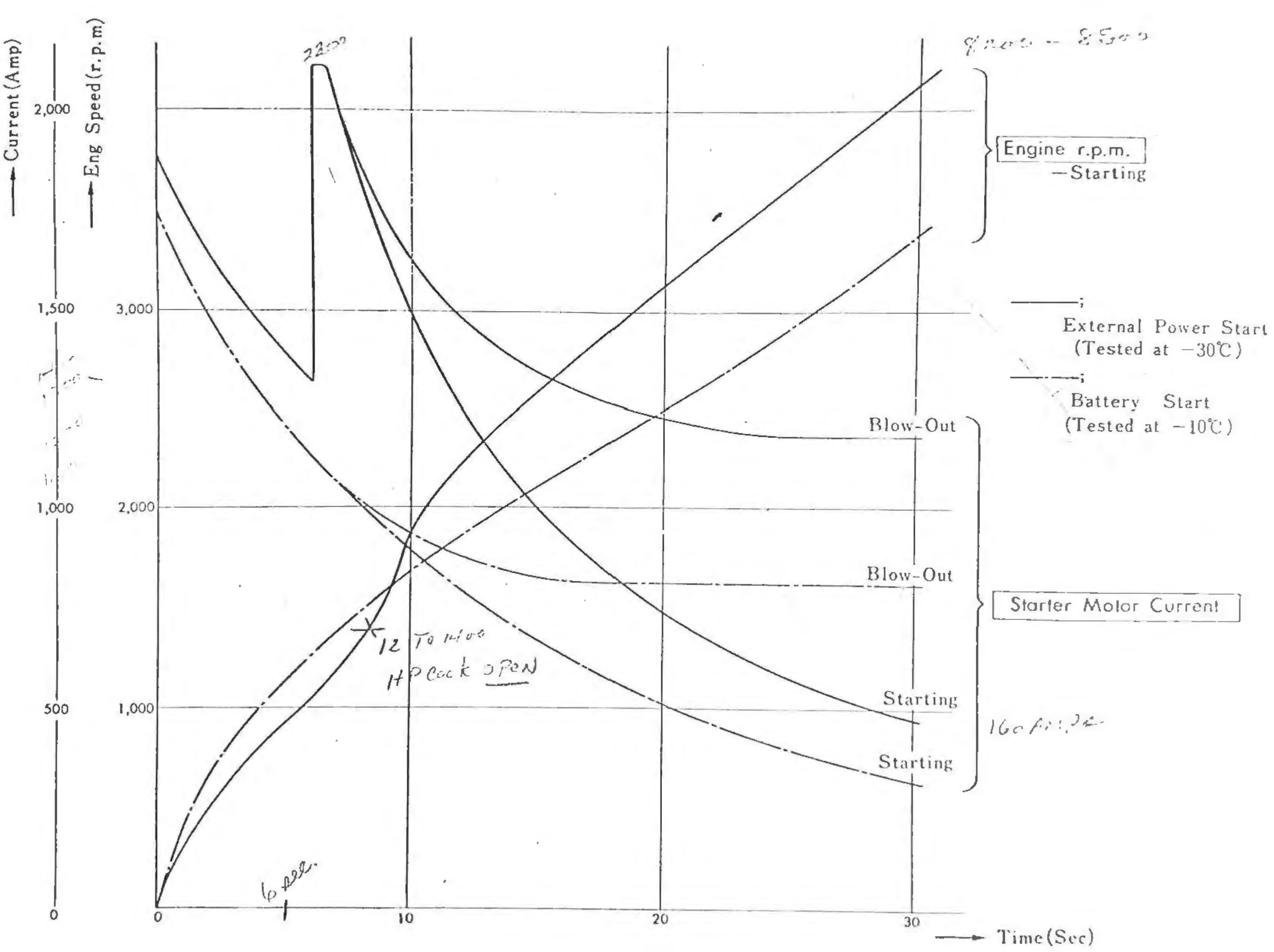
Detail D Starter and Ignition Control Panel

Starter and Ignition System Layout

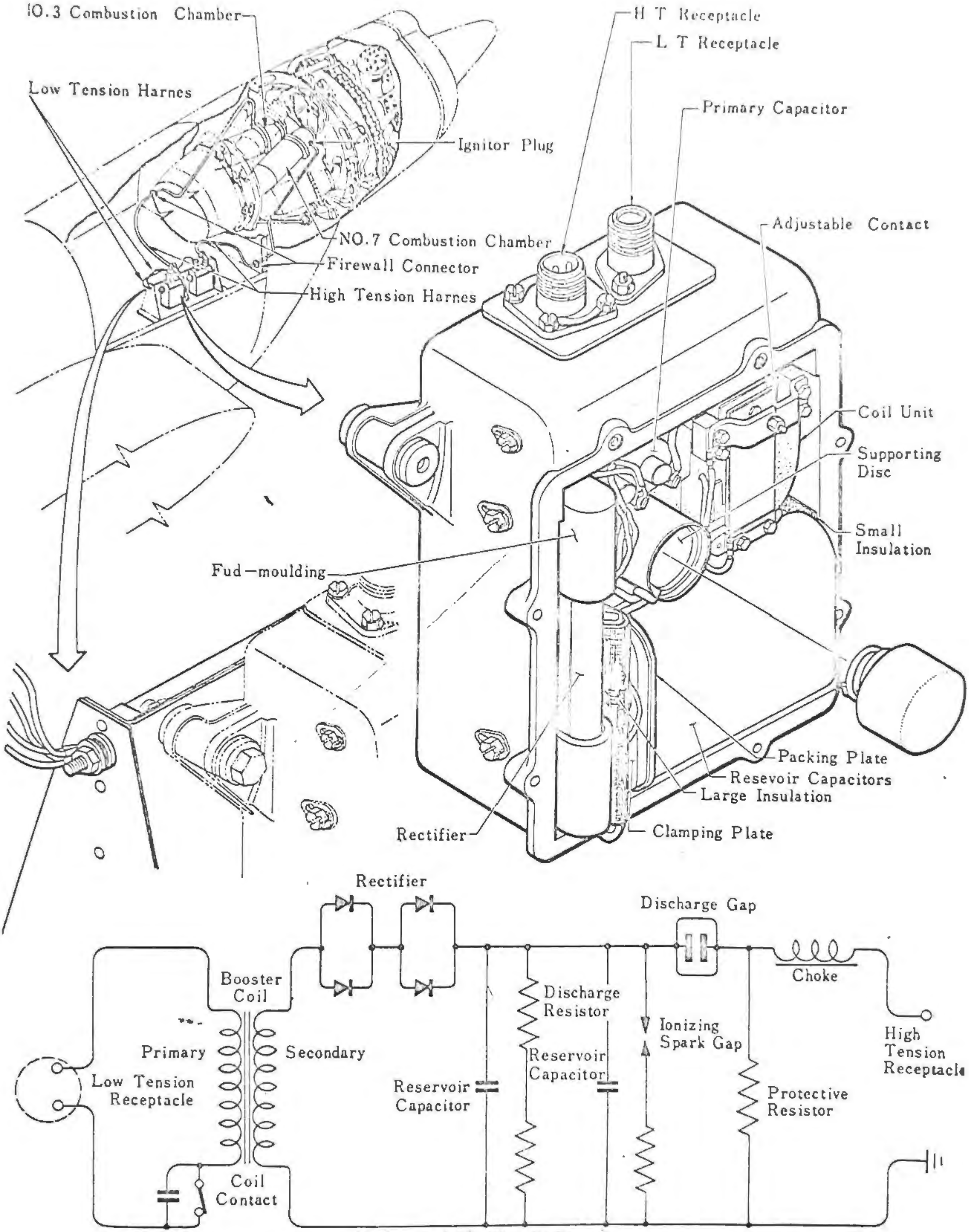
Figure 9-59



F Starter and Ignition System Schematic
Figure 9-60



Starting Characteristics
Figure 9–61



Theoretical Circuit Diagram

Ingnit on Unit (Tipe C34TS/2)

Figure 9-62

Chapter 11 INTERIOR EQUIPMENT AND FURNISHINGS

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Chapter 11 INTERIOR EQUIPMENT AND FURNISHINGS

11.1 General

Details of the arrangement above the floor in the fuselage which is generally called the cabin are varied depending on requirements of individual users, and therefore fundamental sections only will be covered and described in this chapter.

11.1.1 Interior Arrangements above the Floor

The floor space in the fuselage is roughly divided, from the nose to the tail, into the cockpit, the forward cargo compartment, the passengers' compartment, the galley, the lavatory, and the aft cargo compartment.

11.1.2 Strength of Floor

(34" pitch 60 seat)

	Strength of floor Kg/m^2(lbs. sq)	Load limit Kg(lbs)	Flooring material
Passenger compartment	366 (75)	(60 persons)	Aluminum honeycomb
Forward cargo compartment	488 (100)	545 (1,200)	Aluminum honeycomb
Aft cargo compartment	488 (100)	908 (2,000)	Aluminum plate
Belly cargo compartment	317 (65)	500 (1,100)	Aluminum plate

NOTE: Load limit of the forward cargo compartment is variable depending on the number of seats to be installed. It is 680 kg when 52 seats are installed at 38-inch pitch and 1,134 kg when 52 seats are installed at 34-inch pitch. However, in this case, another 454 kg cargo compartment can be provided on the L.H. side, and the total capacity will be 1,588 kg.

11.2 Interior Structure

The flooring is supported by four longitudinal floor beams and transversal floor beams which are provided along each fuselage frame. Railing for the installation of seats is fixed to those beams.

11.2.1 Flooring Materials

For the flooring, two types of materials are employed; aluminum honeycomb panels and aluminum panels reinforced with angles and they are fixed to the floor support beams with screws or rivets.

(1) Aluminum Honeycomb

Aluminum honeycomb material is used as flooring of the passengers' compartment in front of Fus. STA +5160, the forward cargo compartment, the passengers' entrance, and the cockpit aisle.

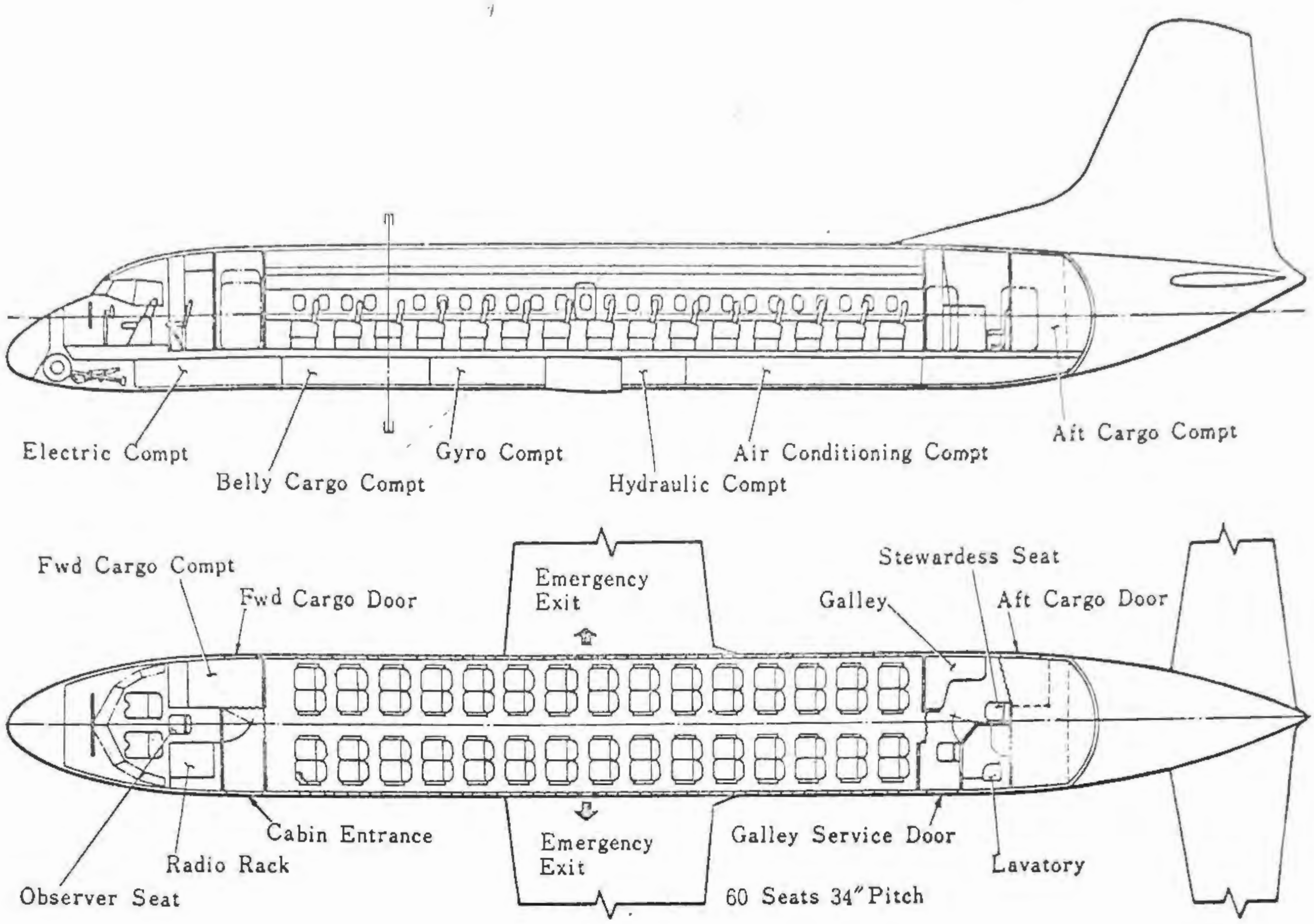
Panels employed for both the passengers' compartment and the forward cargo compartment are 8 mm (5/16 in) thick and the top face of the panel is covered with 0.025 inch clad 7075-T6 sheet and the bottom face with 0.0014 inch clad 7075-T6 sheet.

(2) Reinforced Aluminum Plate

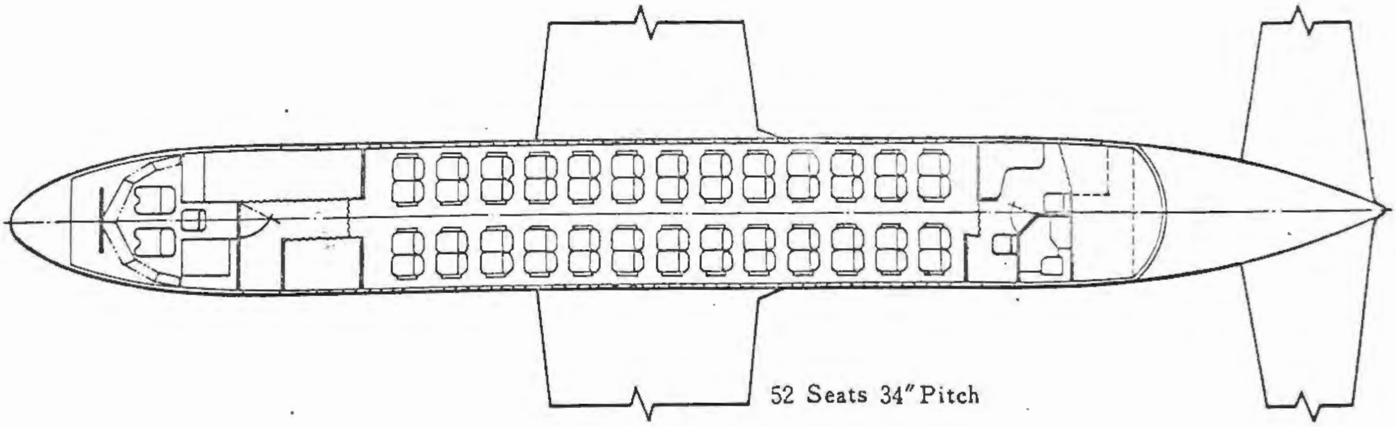
Reinforced aluminum plate is used in covering the floor of the cockpit and the passengers' compartment in the rear of Fus. STA +5160. Its thickness is 0.032 inch and material is clad 2024-T3. The flooring of the cockpit and a part of the aft cargo compartment are fixed with screws and the rest with rivets.

11.2.2 Interior Lining

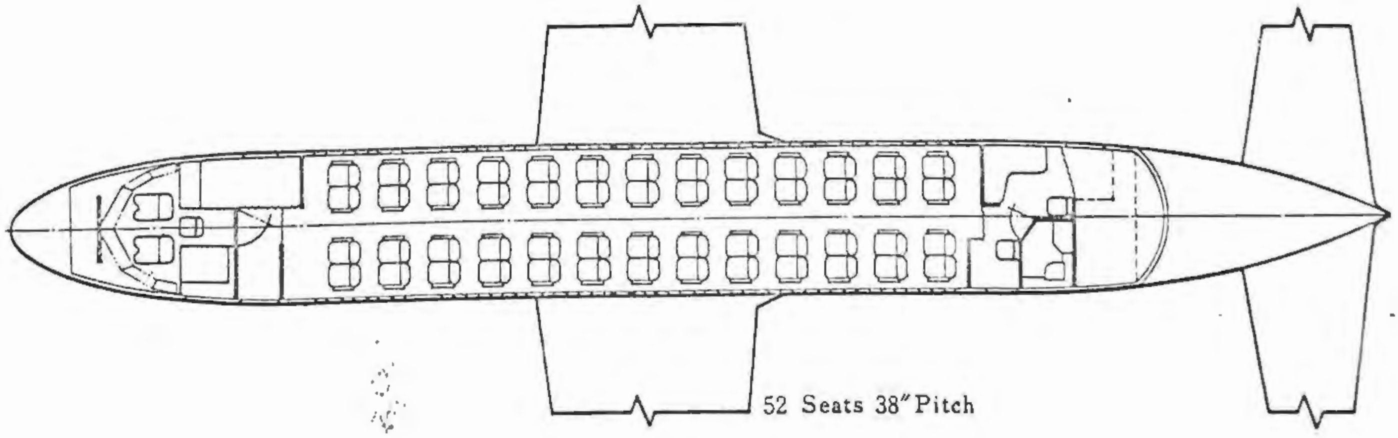
Sound proofing material made up of fiberglass sheeting wrapped in vinyl film is provided to cover the side walls and the ceiling. This sound proofing material is fixed to the fuselage stringers and the flanges with snaps. This material is covered with the ceiling panels and side panels below the windows to provide interior decorations.



60 Seats 34″ Pitch



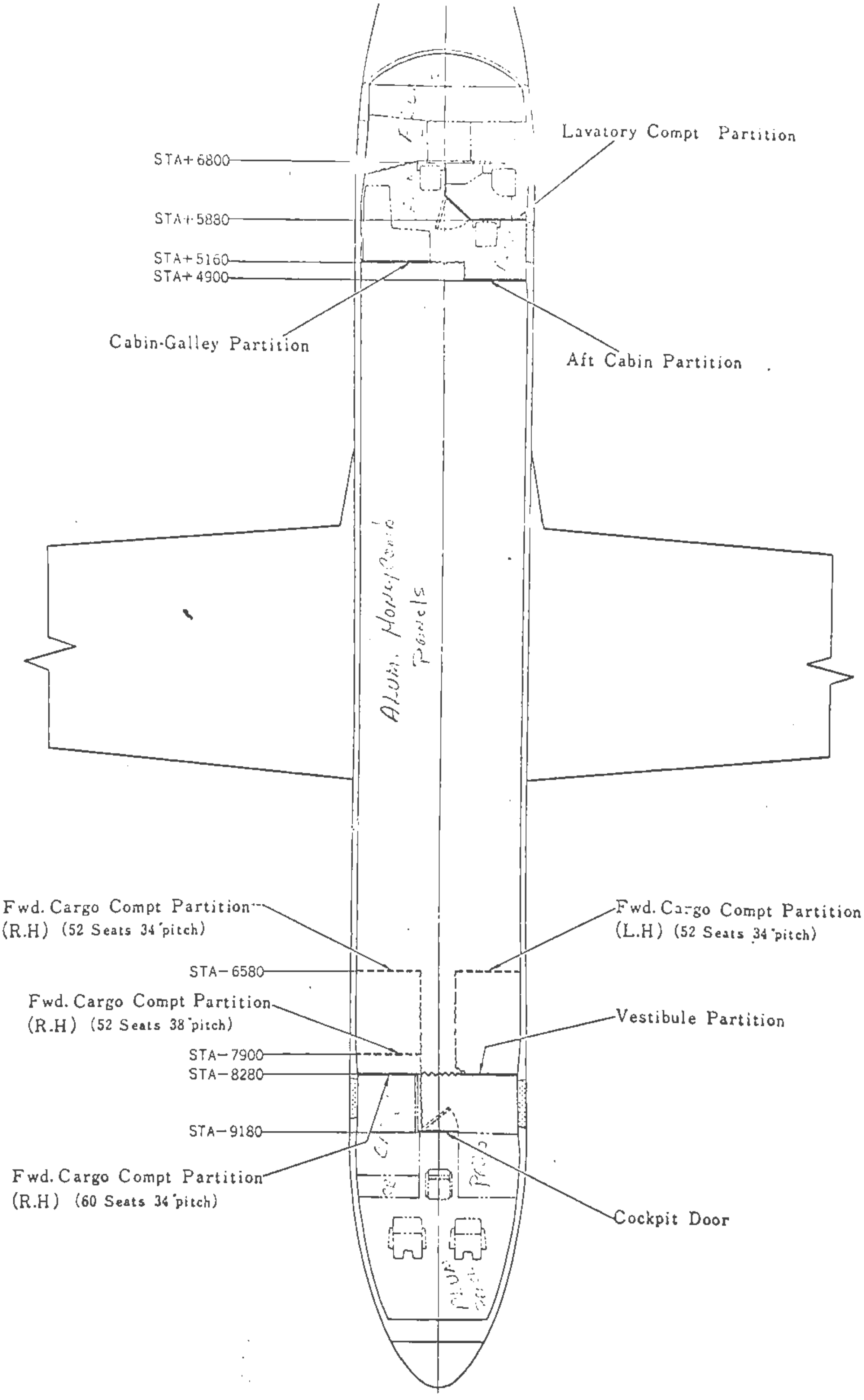
52 Seats 34″ Pitch



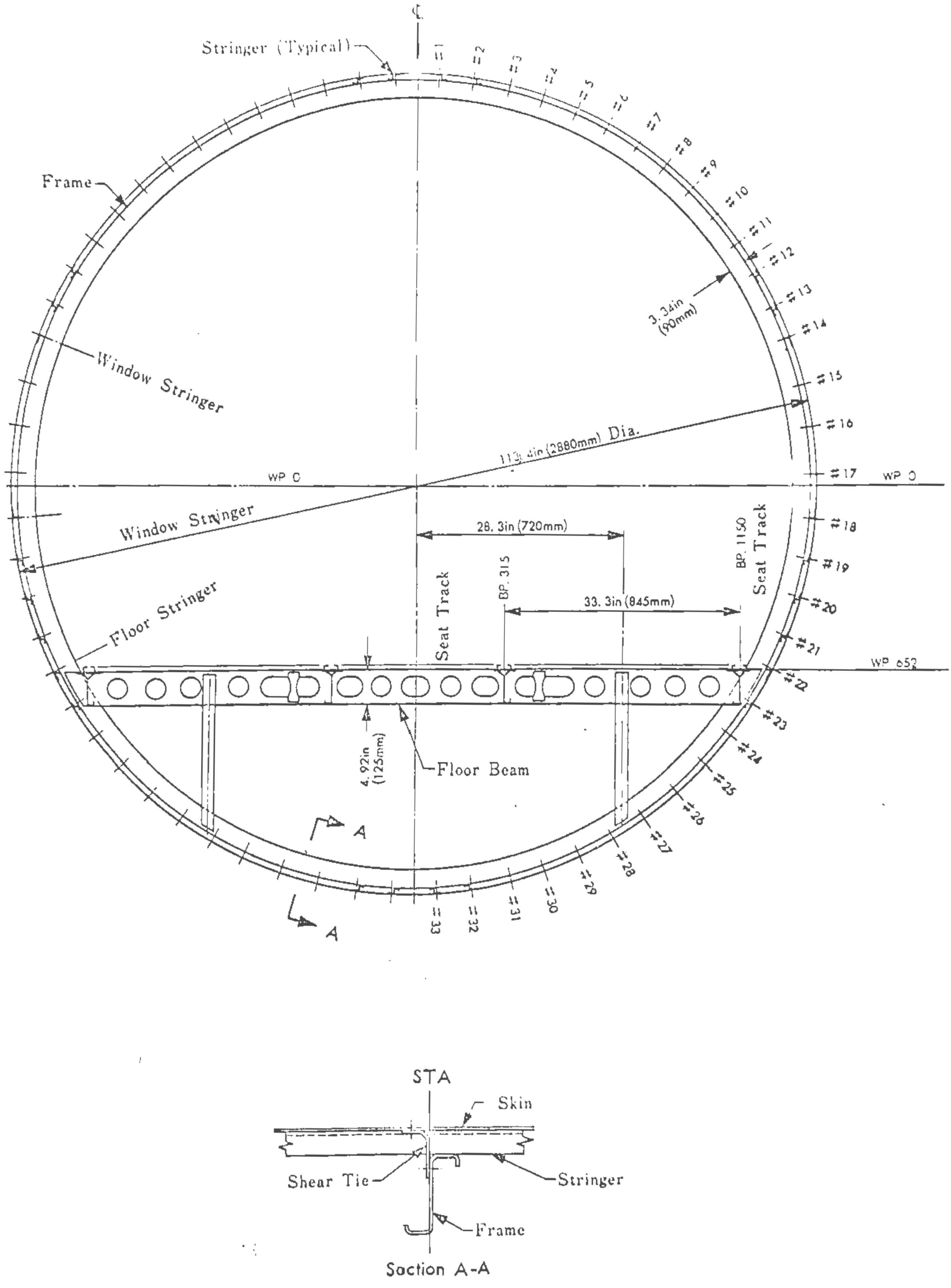
52 Seats 38″ Pitch

Cabin Layout

Figure 11–1

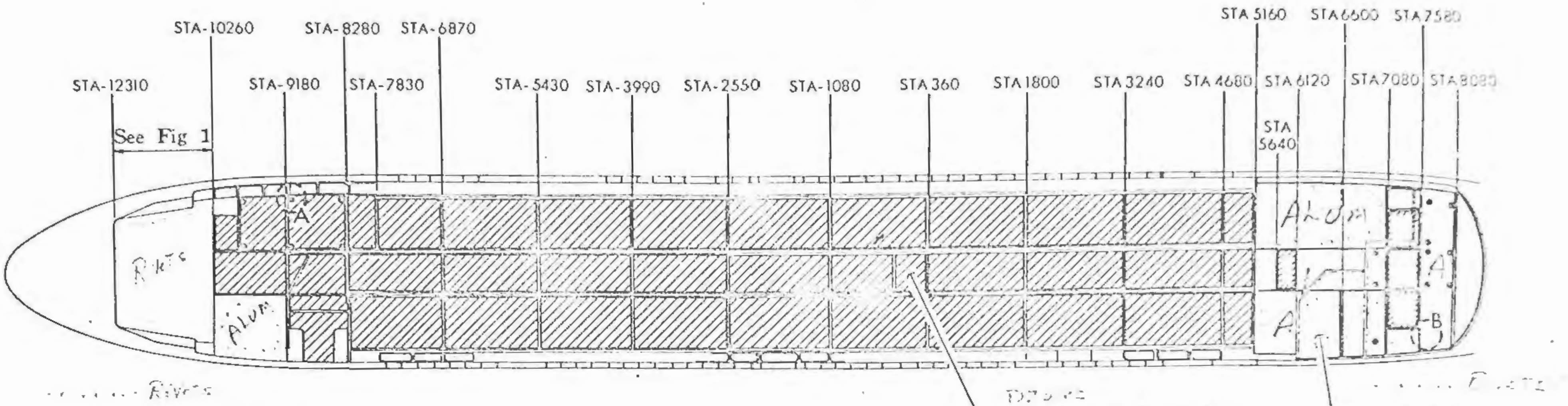

Lavatory Compt Partition
STA+6800
STA+5880
STA+5160
STA+4900
Cabin-Galley Partition
Aft Cabin Partition
Alum. Honeycomb Panels
Fwd. Cargo Compt Partition (R.H) (52 Seats 34"pitch)
Fwd. Cargo Compt Partition (L.H) (52 Seats 34"pitch)
STA-6580
Fwd. Cargo Compt Partition (R.H) (52 Seats 38"pitch)
Vestibule Partition
STA-7900
STA-8280
STA-9180
Fwd. Cargo Compt Partition (R.H) (60 Seats 34"pitch)
Cockpit Door

Door & Partition
Figure 11-2



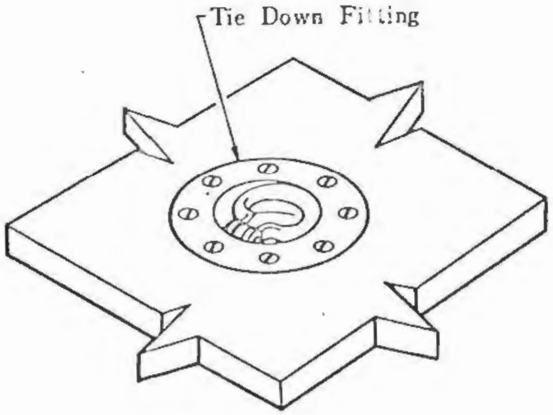
Typical Fuselage Cross Section

Figure 11-3

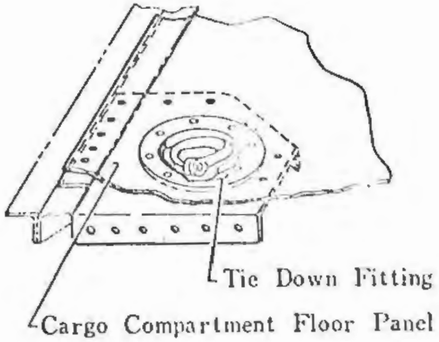


▨ Honeycomb Floor Panel

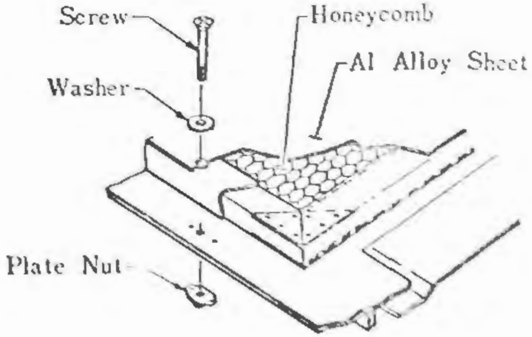
▭ Sheet Metal Floor Panel (Removable)



Detail A



Detail B



Typical Passenger Compartment Floor Panel

Floor Panel
Figure 11-4

(3) Ash Trays

One ash tray is provided beside each cup holder.

(4) Microphones

The microphones which are provided under the right and the left side consoles are used for communication with the control towers and the stewardesses.

(5) Hand Set

One hand set is installed on the wall on the L.H. side behind the pilot's seat and this is used by the pilot to give instructions and guidance to the passengers. The hand set hanger is provided with a microswitch and, thus, when the hand set is taken out of its hanger, the interior addressing circuit for the stewardess is made enabling the pilot to speak directly to the passengers.

(6) Map Case

(7) Escape Ropes

Escape ropes are contained 1 ea. in the walls above the right and left sliding windshields, respectively.

(8) Life Vests

Life vests for the pilot and the copilot are contained 1 ea. in the lower part of the side panels, and one for the observer may be kept behind the seat of the copilot.

(9) Pilot and Copilot Seats

The seats are mounted on railing and therefore it can be moved back and forth. Notches are provided in the railing and thus the seats can be locked at desired positions. The height of the seats can be also adjusted and can be locked at required levels.

(10) Observer's seat

An observer's seat is installed on the floor of the cockpit aisle. It is of collapsible type and when folded, it can be lowered to the level of the floor. The procedures for folding this observer's seat are described on the M.J.B. wall. The reverse side of the back-rest of the observer's seat is coated with slip preventive pain SR 8355 (MIL-W-5044A Type II).

11.4 Passenger Compartment Furnishings

11.4.1 Appearance

Hat racks are installed beneath the ceiling along both sides of the passengers' compartment. Near the fixing joints of each hat rack are provided hot air outlets, and on the bottom face of the hat rack are installed passenger service panels. 13 room lights and 14 passenger addressing speakers (in two rows, 7 speakers each) are provided on the ceiling. The windows are provided with curtains and the louvers are installed for interior ventilation in the side panels below the windows. The floor is covered with carpet which is fixed in place with Velcro tape.

11.4.2 Passenger Service Panels

30 passenger service panels are provided and distributed in conformity with the arrangement of the seats. The following devices are installed in each passenger service panel:

Reading lights and their switches	2 each
Cool air outlets	2 each
Stewardess call buttons	2 each

(1) Reading Lights

Angle of the reading lights can be adjusted to suit the posture of the passengers. Their switches are of push button type and the lights can be put on and off by depressing the push buttons. Furthermore, the lights are provided with diaphragms for the adjustment of light intensity.

(2) Cool Air Outlets

Cool air of approximately 4°C comes out of the cool air outlets. Flow rate of the cool air can be controlled from zero to the maximum, and the angle of the air flow can be adjusted according to the posture of the passenger.

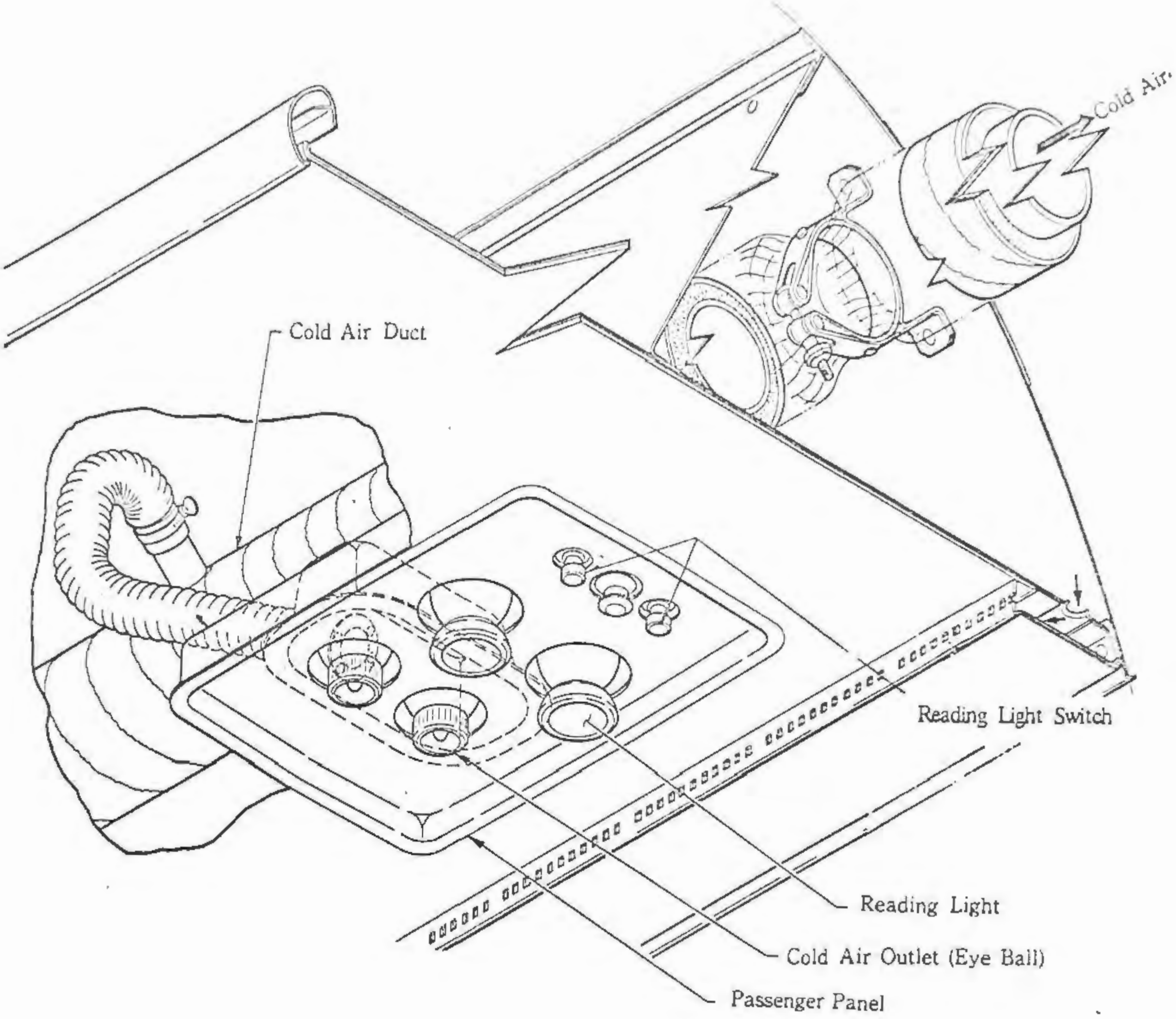
(3) Stewardess Call Buttons

The stewardess call button is used when a passenger wants to call the stewardess. When the button is depressed, the chime in the aft stewardess panel sounds and concurrently the passenger call lamp lights up. At the same time, the red lamp contained in the call button comes on, indicating the location of the calling passenger. The light goes off if this call button is pulled down.

11.4.3 Interior Lighting

For interior lighting, circular white fluorescent lamps are employed and for the night are small incandescent lamp is also contained in each fluorescent lamp for use at night. All the interior lighting is put on and off from the stewardess panel and its light intensity can be adjusted

Reading Light Switch



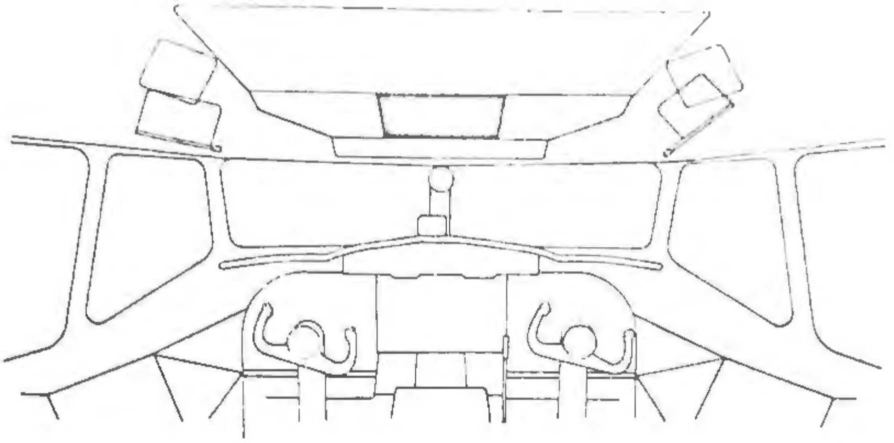
Reading Light Switch

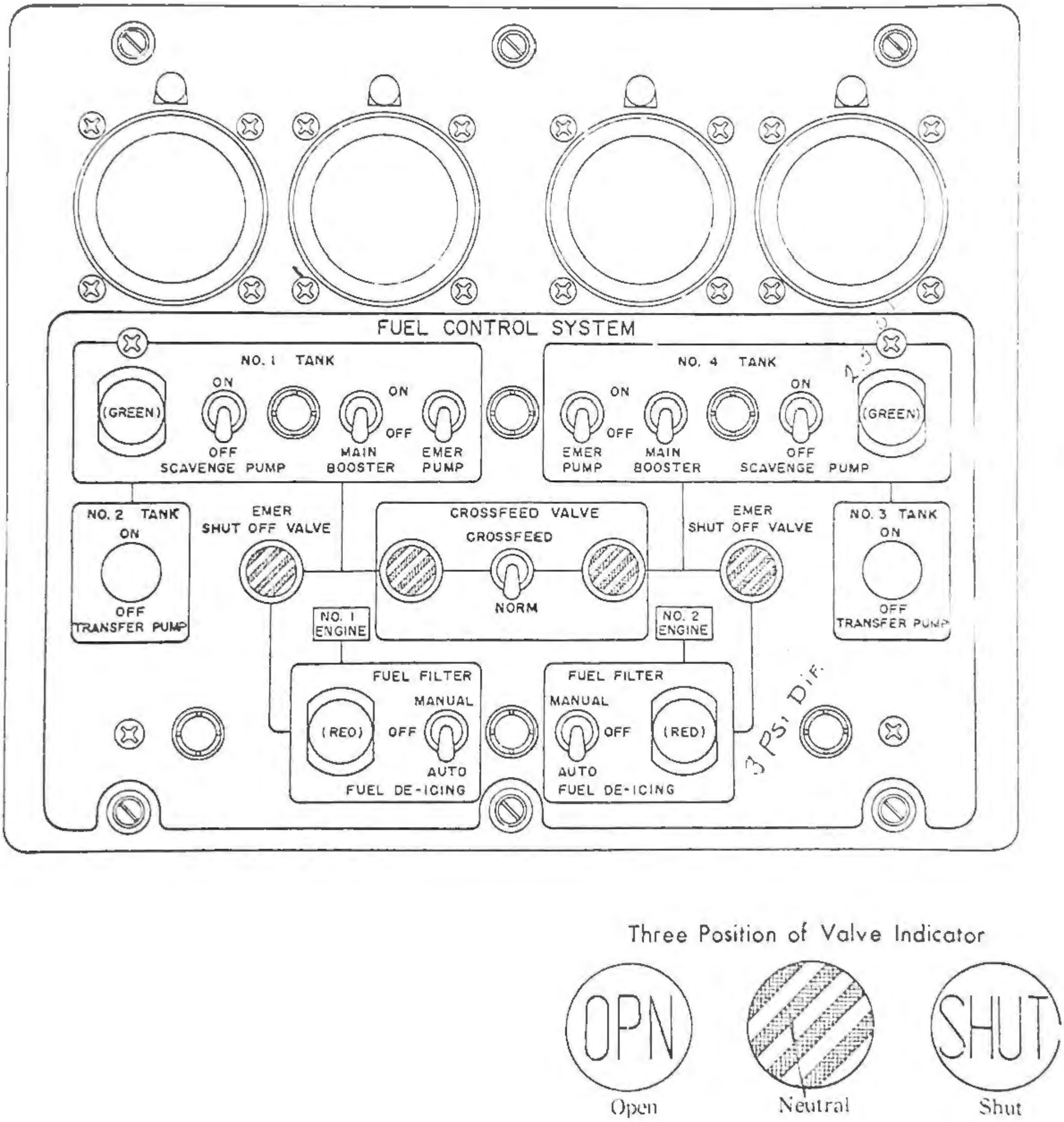
Old; Manufacture .... MIYAMA

New; Manufacture .... NIPPON KAIHEIKI

P/N SB265N

Due to increase the reliability. The leading light switches were changed to new ones.





Ⓡ
Low P
ON -
OFF- /

Fuel Control Panel
Figure 5–14

5.5.2 Collector Tank (See Figs. 5-20 and 5-21)

The collector tank is of a square box-type isolated chamber made of aluminum alloy located at the lowest location of the integral tank.

Its dimensions are about 350 mm in width, 280 mm in depth and 360 mm in height. The tank consists of the upper and lower assemblies, which are joined together by bolts through gaskets.

In the upper assembly are installed the fuel relief tube having a flapper valve and the collector tank vent line. The flapper valve is designed to open when collector tank internal pressure accumulates above 0.05 psi than main tank pressure. The duty of this valve is to protect the collector tank from damage due to fuel delivered from the scavenge pump. The collector vent line is opened into the integral tank. In the lower assembly, the following units and components are installed:

Booster pump	2 ea.
Booster pump outlet port	2 ea.
Fuel inlet port from scavenge pump	1 ea.
Flapper valve	2 ea.
Flapper valve closing knob	2 ea.
Aluminum conduit for wiring	1 ea.

5.5.3 Booster Pump (See Figs. 5-22, 5-23 and 5-24)

The booster pump is a high-speed centrifugal pump driven by an anti-explosion type motor which operates on 27 volt D.C. power.

The pump and motor form an integral unit and are of submerged type.

Upper half of the pump incorporates an anti-explosion type motor, at lower half of the pump is installed an impeller connected to motor shaft, and at the bottom of the pump are installed radio noise filter, vent hole, pump drain hole and drain fitting for leakage in the sealed portion of the motor shaft.

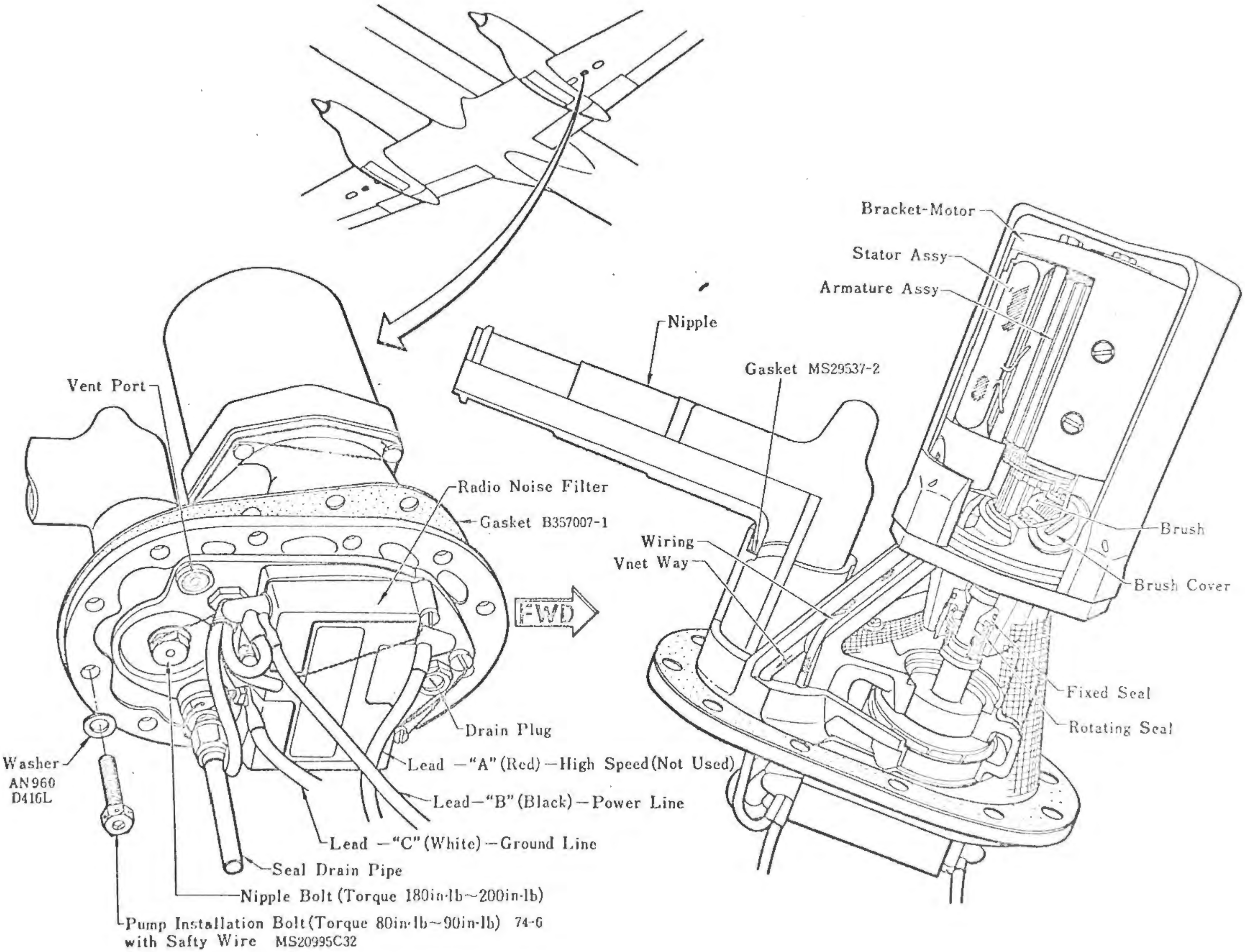
To prevent fuel from leaking into the motor room, a combination of rotating seal and fixed seal, mechanical seal and labyrinth seal is used.

A by-pass valve, which leads fuel directly to the pump outlet through the flapper valve by-passing the impeller, is installed in the pump.

During the time the impeller is in operation, bubbles come up from around the impeller. Thus vapor lock can be prevented. Two booster pumps are installed, one for normal use and the other for emergency, both of which are of entirely the same type and same capacity.

The power sources of pump motors are as follows:

For normal use	D.C. main bus
For emergency	D.C. emergency bus

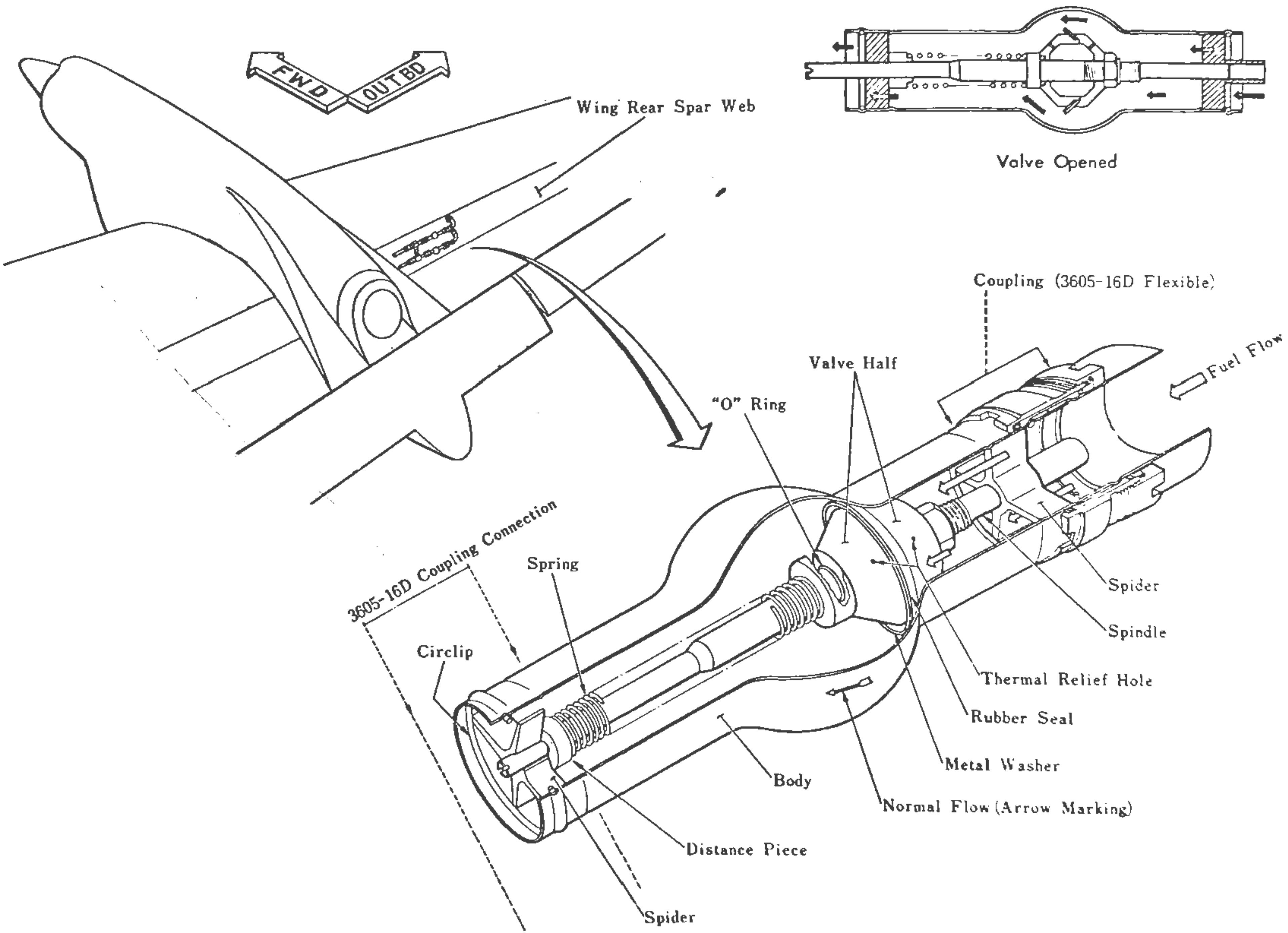

Bracket-Motor
Stator Assy
Armature Assy
Nipple
Gasket MS29537-2
Vent Port
Radio Noise Filter
Gasket B357007-1
Wiring
Vnet Way
Brush
Brush Cover
FWD
Fixed Seal
Rotating Seal
Drain Plug
Washer
AN960
D416L
Lead — "A" (Red) — High Speed (Not Used)
Lead — "B" (Black) — Power Line
Lead — "C" (White) — Ground Line
Seal Drain Pipe
Nipple Bolt (Torque 180in·lb~200in·lb)
Pump Installation Bolt (Torque 80in·lb~90in·lb) 74-6
with Safty Wire MS20995C32

Booster Pump Out Side View
Figure 5–24

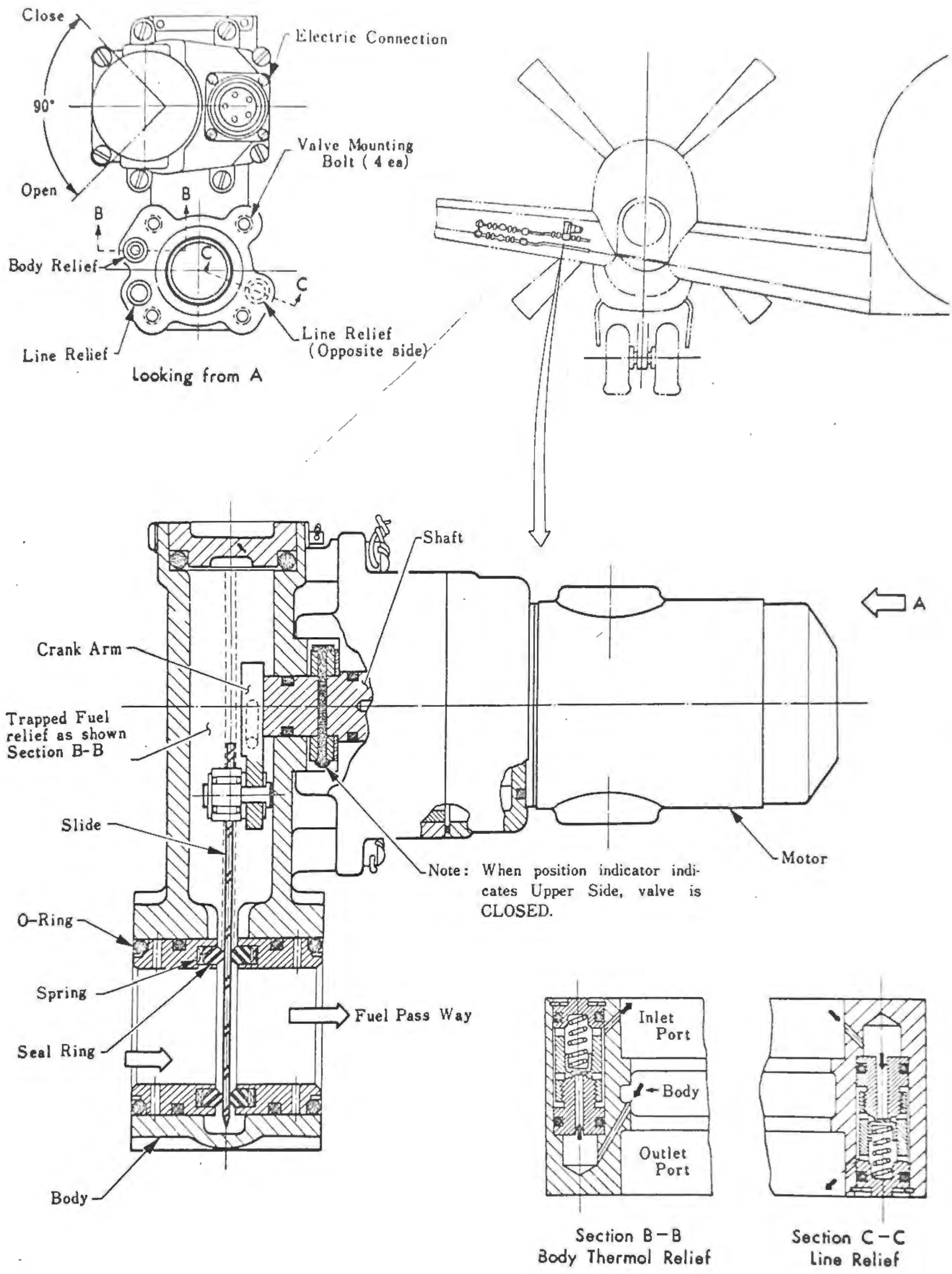
5.5.7 Drain Valve

The drain valves in the tank and fuel lines consist of the following:

Pipe dia.	Part Number	Name of the valve	Q'ty
1/4 inch	KIF20000-1	Cross Feed Line Drain	3
		Pressure Refuel Drain	1
		Sensing Line Drain	2
1/4 inch	KIF20000-6	Fuel De-icing Test Shut-off	2
		Integral Tank Water Drain	2
1 inch	EIP30000-1	Scavenge Inlet Shut-off	4
1 inch	EIP30000-4	Fuel System Power Drain	1
1 inch	EIP30000-5	Integral Tank Drain	2

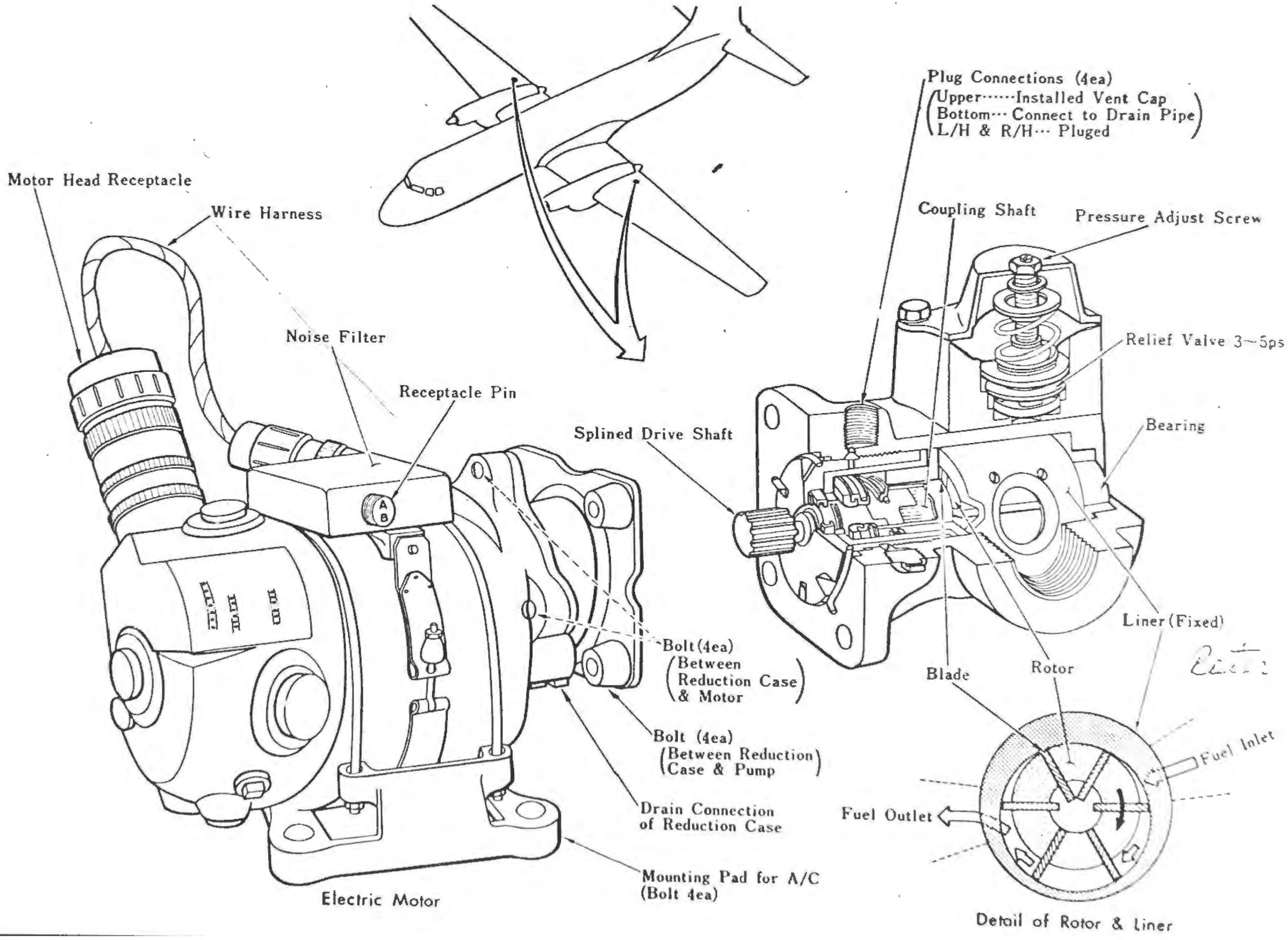


Non-Return Valves
Figure 5-25


Close
Electric Connection
90°
Valve Mounting Bolt (4 ea)
Open
B
B
C
Body Relief
C
Line Relief
Line Relief (Opposite side)
Looking from A
Shaft
A
Crank Arm
Trapped Fuel relief as shown Section B-B
Slide
Note: When position indicator indicates Upper Side, valve is CLOSED.
Motor
O-Ring
Spring
Fuel Pass Way
Seal Ring
Body
Inlet Port
Body
Outlet Port
Section B – B Body Thermol Relief
Section C – C Line Relief

Fuel Emergency Shut-off Valve Cross Section View Schematic

Figure 5–26



Fuel Integral Tank Scavenge Pump Cut-Away

Figure 5-27

5.6 Fuel De-icing System

5.6.1 Functions

The fuel heater is installed on the fuel feed line to prevent the fuel from icing and choking the low pressure filter. Heat source of the fuel heater is the bleed air from the second stage of the engine. In the bleed air line the solenoid valve (bleed air gate valve) is installed.

Icing and choking at the low pressre filter is detected by the pressure difference between the up-stream and down-stream of the filter. Pressure in the up-stream is sensed immediately before the fuel flow transmitter while that in the down-stream is sensed at the outlet of the low-pressure filter.

When this pressure difference exceeds 3 ± 0.2 psi, the pressure switch in the sensing line closes its contact point to light the fuel de-icing warning light (red) on the upper instrument panel in the cockpit.

Hot air extracted from the second stage of the engine passes through hot air valve and flows into the fuel heater to perform de-icing.
About 4% of the power delivered from the engine is consumed to perform de-icing by the hot air.

5.6.2 Switch Position

The gate valve on the bleed air line performs three missions according to the control switch positions in the cockpit.

Control Switch Position

OFF .... Engine bleed air does not flow even when fuel de-icing warning light is on. (Heater is not in operation)

Gate valve is always CLOSED.

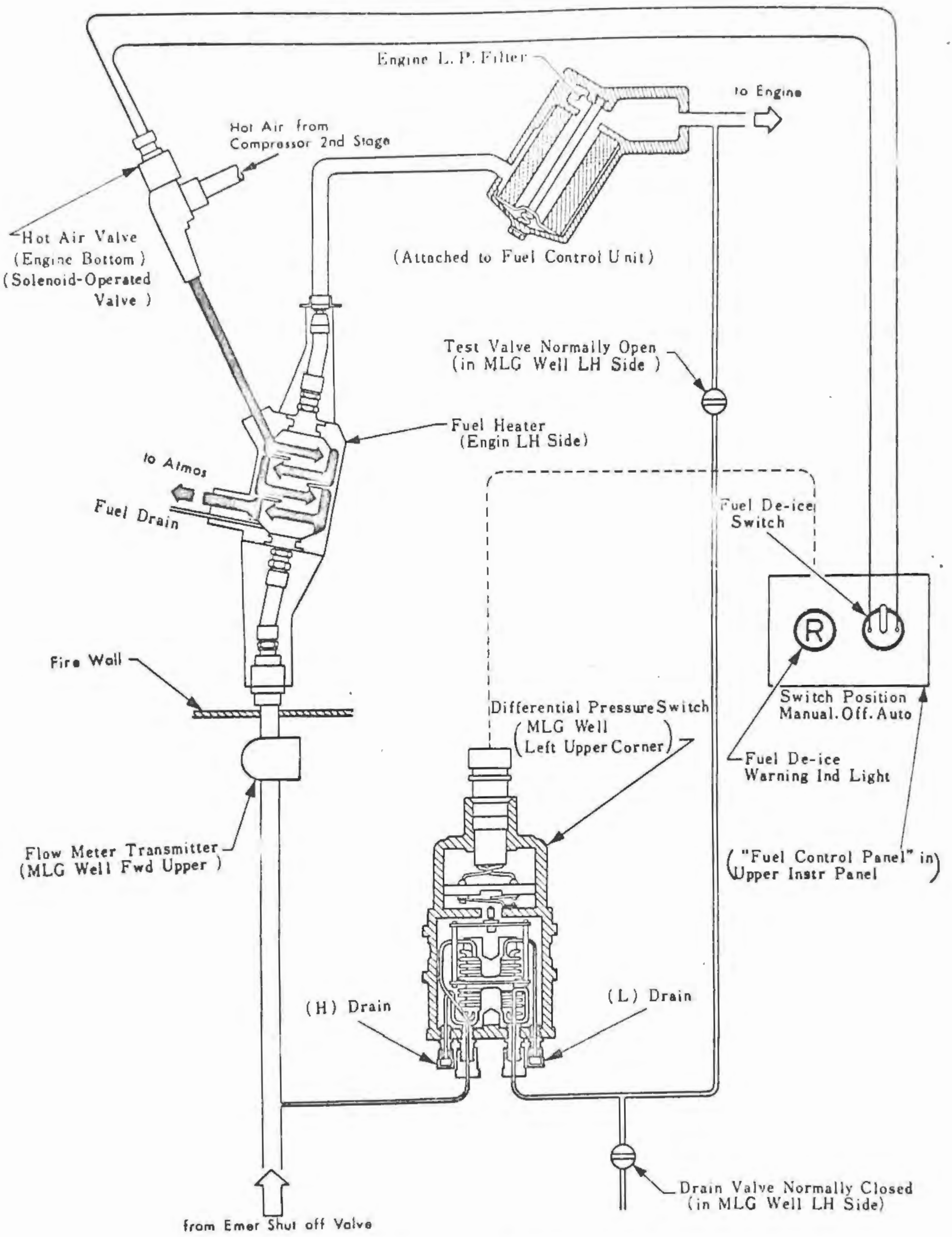
Auto .... Engine bleed air starts flowing automatically and simultaneously when fuel de-icing warning light comes on. (Heater is in operation.)

Gate valve is OPEN

Manual .... Engine bleed air flows even when fuel de-icing warning light is not on. (Heater is in operation)

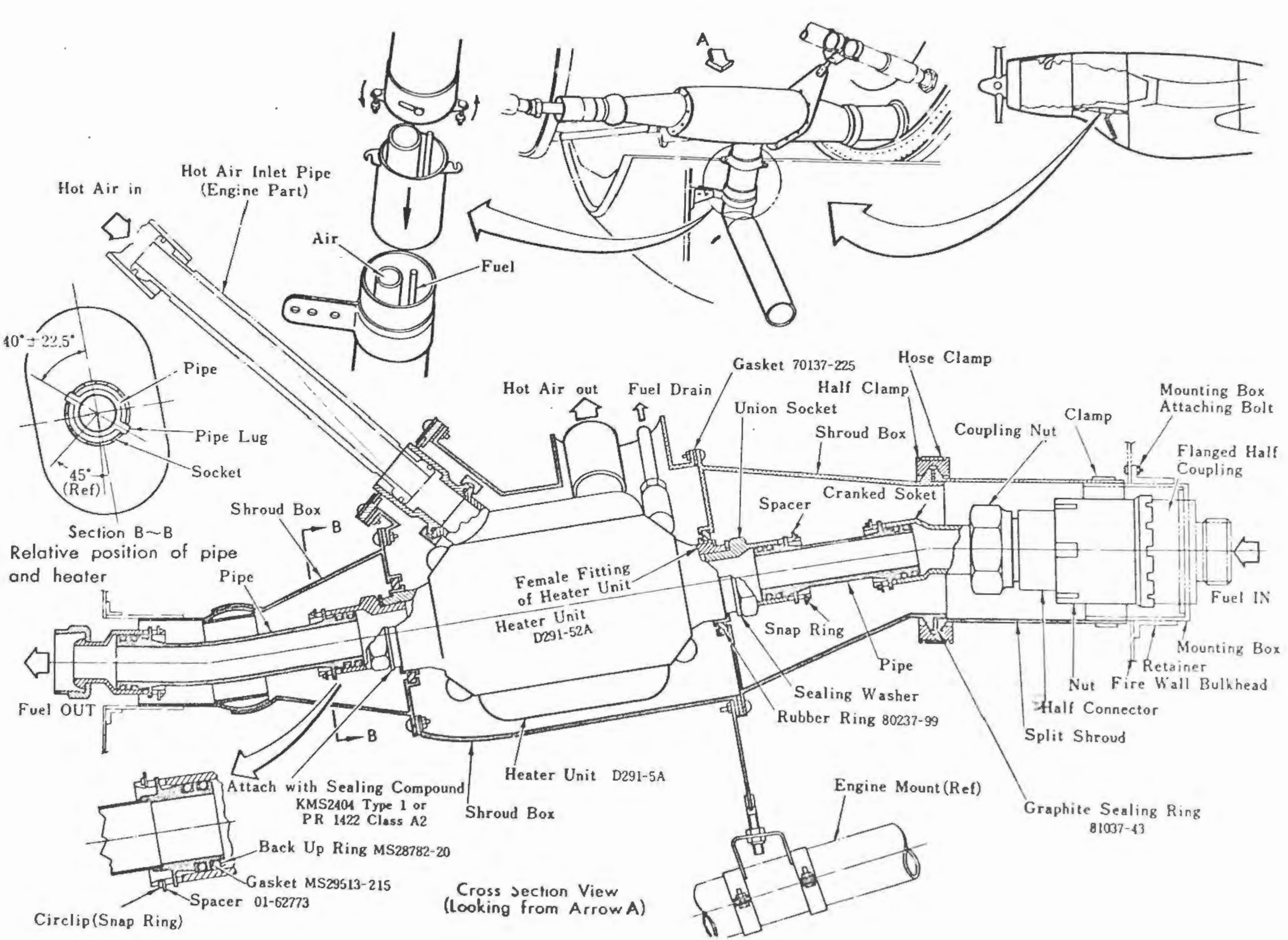
Gate valve is always OPEN.

The fuel heater is of such a construction that the fuel passage is straight and the engine bleed air crosses the fuel flow line at the right angle.

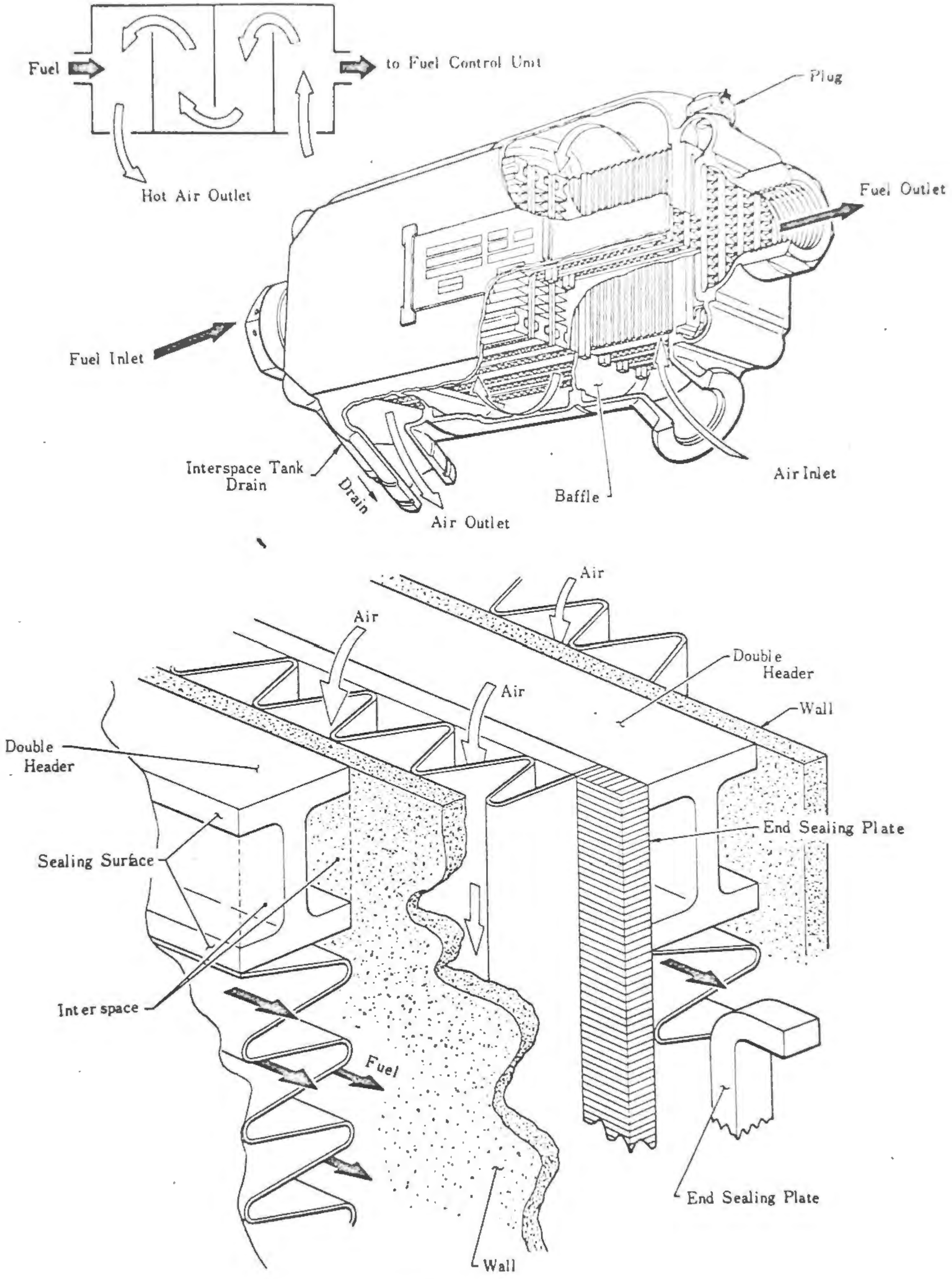


Fuel Heating (Engine Filter De-icing) and Warning Control Schematic

Figure 5–29



Fuel Heater
Figure 5-30



Fuel Heater Construction

Figure 5-31

5.6.3 Major Components of Fuel De-icing System

(1) Fuel Heater Unit

(2) Differential Pressure Switch

(3) Hot Air Valve

(4) De-ice Switch

The fuel de-icing system is operated by above-mentioned major components automatically or manually.

On airplanes #62 and later are provided the fuel temperature indicating system which has a fuel temperature bulb in the F.C.U. filter to sense the fuel temperature, sending signals to the dual type gauge on the R/H side panel. Thus, the reference temperature for fuel de-icing operation is changed from O.A.T. to the fuel temperature.

5.7 Fuel Quantity Indicating System

Two kinds of fuel quantity indicators are employed.

(1) Direct-reading fuel quantity indicator designed to indicate the volume of fuel.

(2) Fuel quantity indicator designed to indicate the weight of fuel.

5.7.1 Direct-Reading Fuel Quantity Indicator

This type of fuel quantity indicator is installed only in No. 1 and No. 4 fuel tanks, on the manhole cover plates at W STA 4800 and W STA 8000 of the lower surface of the wing, respectively. They are so installed as to be read directly under the wing.

The scale indicates the fuel quantity in the unit of U.S. gallons. The indicator is graduated at intervals of 50 U.S. gallons. The indicator, designed to indicate the fuel level, consists of float, shaft, magnet and magnetic pointer.

The vertical movement of the float is converted into the rotation of the shaft. On the lower end of the shaft is installed the magnet. The magnetic field is changed by turning of this magnet. Following the changes in the magnetic field, the magnetic pointer rotates and indicates the fuel quantity.

The range of indication by this indicator is as follows.

Inboard side	75 to 425 U.S. Gal.
Outboard side	450 to full U.S. Gal.

5.7.2 Fuel Quantity Indicator Designed to indicate the Weight of Fuel

The indication system is of electrical capacitance type. The transmitter submerged in the fuel generates and sends a signal to the indicator as electric capacitance varies with the change of fuel level.

Electric power for functioning is extracted from constant frequency main bus. The indicator is graduated in the unit of pound, at intervals of 100 lbs.

The three tank units are submerged in the tank as parallel circuits. The compensator which compensates the fuel quantity for variation of temperature is also submerged. These tank units and compensator as a transmitter sense the fuel quantity.

Measurement of Actual Quantity of Loaded Fuel

Gravimeter reading x 8,344 = Density (Lb/Gal.)

Major Components of the Indicating System is as follows:

(1) Indicator

(2) Tank Unit and Compensator

(3) Amplifier

NOTE: For the components of the indicating system, see Chapter 8, INSTRUMENT SYSTEM.

5.8 Optional Equipment - Bag Tank

As the optional equipment of the fuel system, provisions for auxiliary tank installation are installed.

The aircraft is equipped with all necessary piping and wiring for auxiliary tanks. The dotted line part in Fig. 5-1 becomes effective only when auxiliary tanks are installed. When no auxiliary tanks are mounted, the piping is sealed with a blind cover at the inlet of the tank.

And, in place of a shut-off valve and a pressure switch in the line of the optional equipment, their dummies are installed. The wiring provision is blinded with plugs and not connected to the electric power source.

5.8.1 Auxiliary Tank

No. 2 and No. 3 tanks are bladder type bag tanks installed between wing spars inside the engine nacelle. The inner walls of the room enclosed by the wing spars are made from fabric reinforced plastic boards.

No. 2 tank consists of two cells while No. 3 tank of three cells. On the bottom and ceiling are installed interconnector fittings for the connection of cells, which are interconnected by pipes.

Bottom ....2-1/2 inch dia. pipe for fuel flow
Ceiling ....2-1/2 inch dia. pipe for tank vent

The tank is secured by button hangers to the side wall and by snap fasteners to the ceiling. Each inner wall has a guide.

The inter connectors of the tank is joined together with bolts with a tightening torque of 25 ± 5 inch-pounds.

5.8.2 Specifications of the Tank

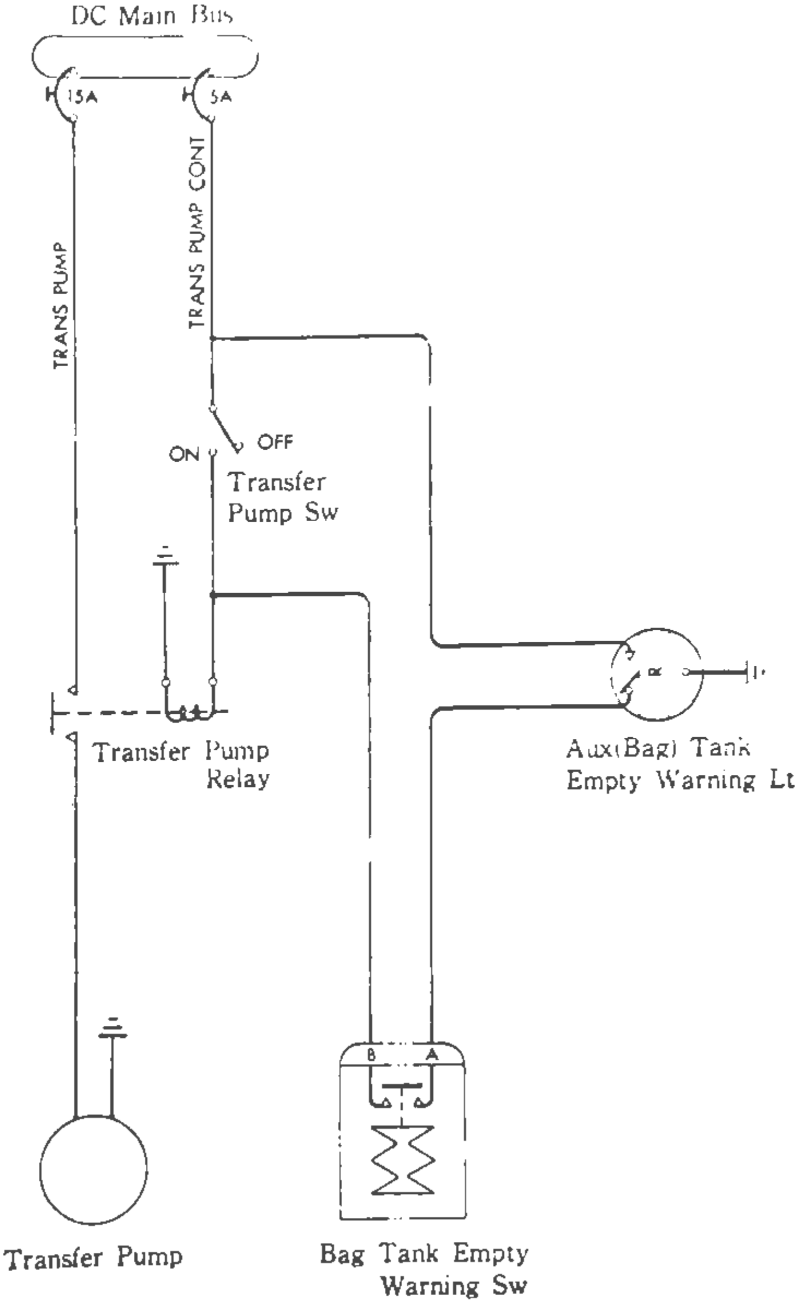
	No. 2	No. 3
Total Capacity	909 ℓ	1,438 ℓ
Unusable Fuel Amount	7 ℓ	7 ℓ
Expansion Space	39 ℓ	78 ℓ

5.8.3 Fuel Refueling System

(1) Gravity Refueling

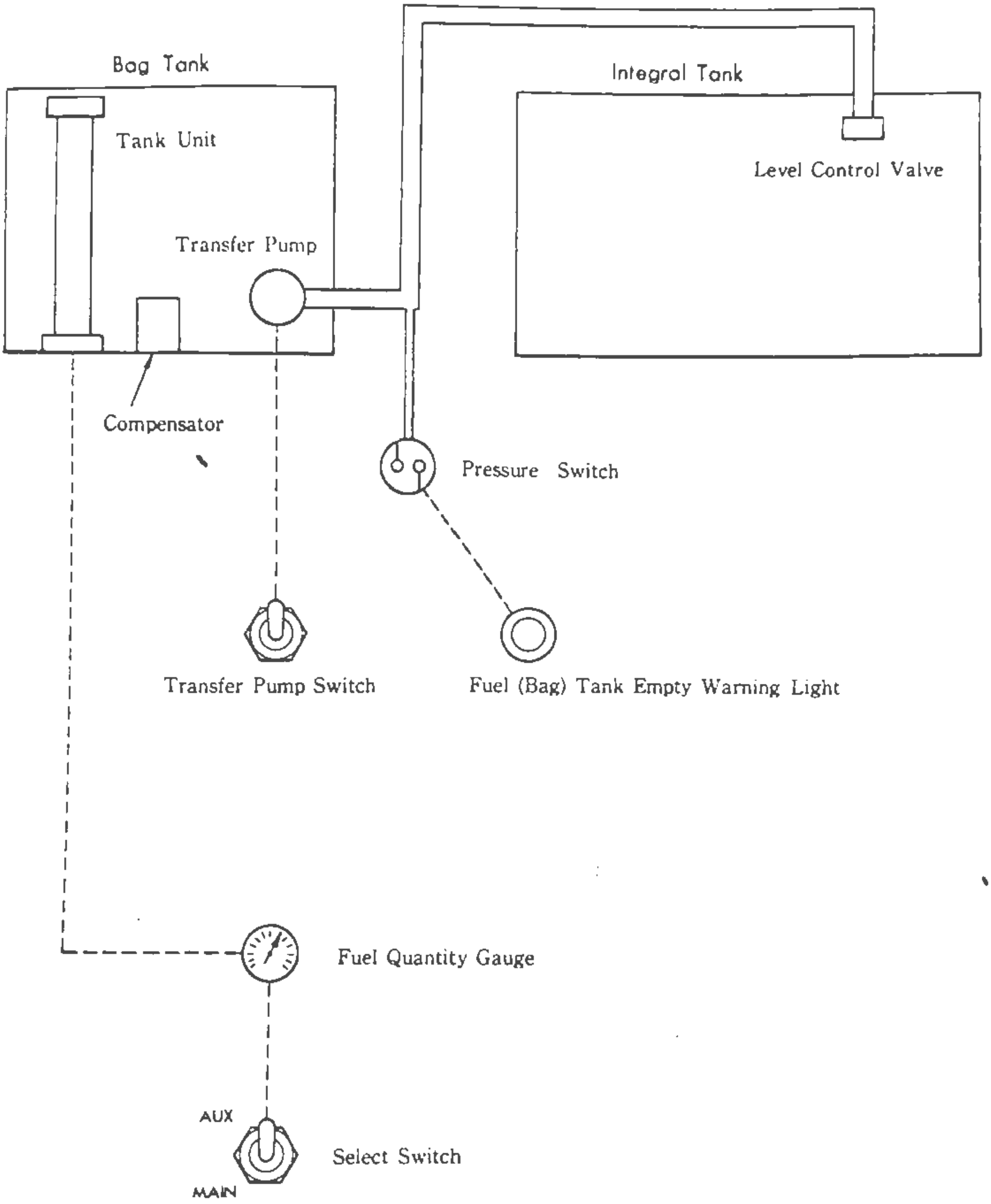
A filler cap for fuel refueling is installed on the upper surface of the wing at the tank location as alternative refueling means. Gravity refueling amount of fuel is as follows:

No. 2 Tank	870 ℓ	(about 230 U.S. Gal.)
No. 3 Tank	1,360 ℓ	(about 359 U.S. Gal.)



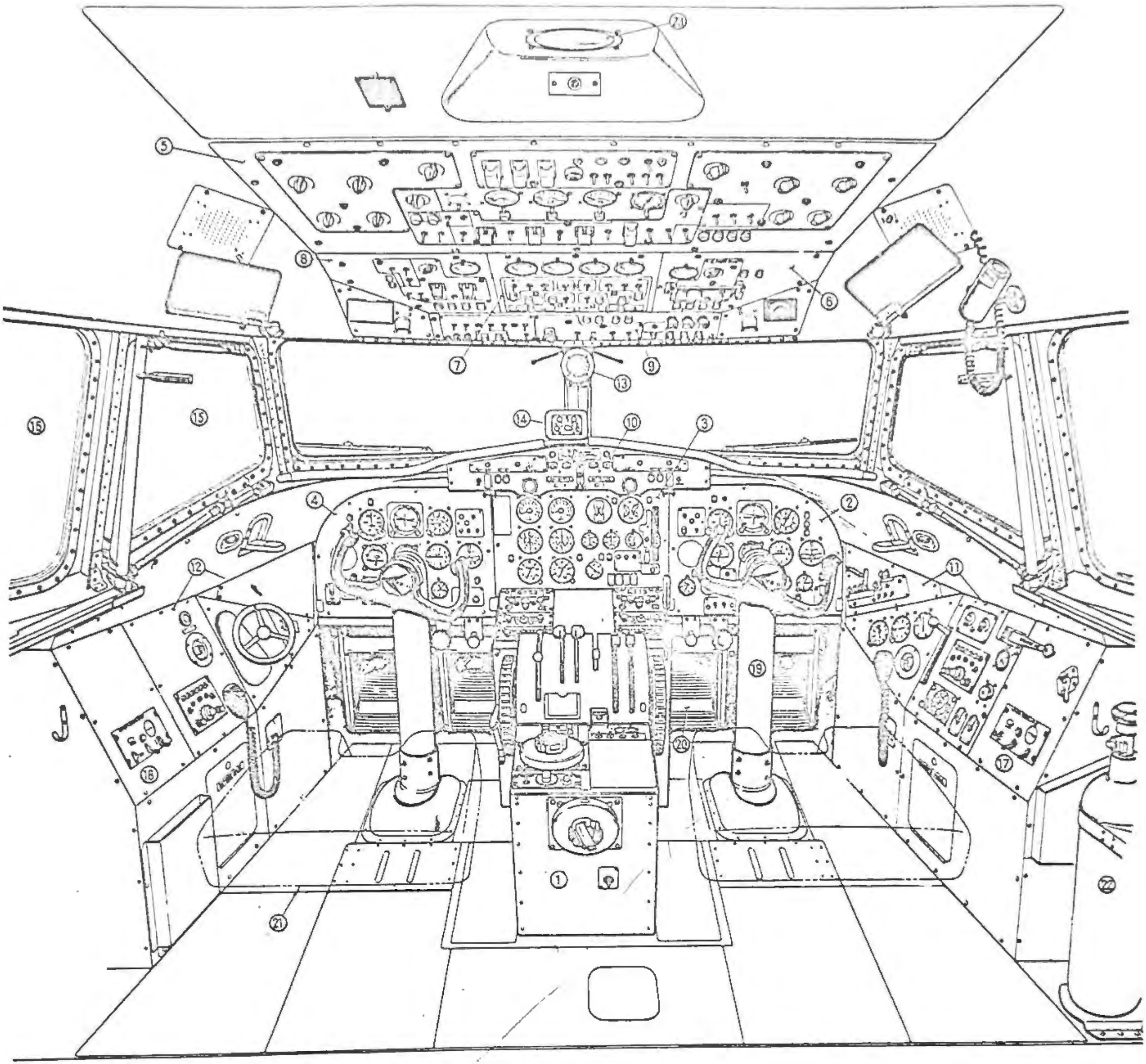
Fuel Transfer System Theoretical Diagram

Figure 5-33A



Fuel Bag Tank System

Figure 5-33B



① Pedestal
② Copilot Flight Instrument Panel
③ Engine Instrument Panel
④ Pilot Flight Instrument Panel
⑤ Overhead Panel Aft
⑥ Overhead Panel RH
⑦ Overhead Panel Center
⑧ Overhead Panel LH
⑨ Overhead Panel Fwd
⑩ Auxiliary Panel
⑪ RH Side Panel
⑫ LH Side Panel
⑬ Stand By Compass
⑭ IIS Mode Selector Switch
⑮ Slide Window
⑯ Side Window
⑰ RH Console
⑱ LH Console
⑲ Control Column
⑳ Rudder Pedal
㉑ Pilot Seat
㉒ Flight Crew Oxygen Bottle
㉓ Dome Light

Cockpit General View
Figure 11-5

(1) Ceiling Panels

The ceiling is made up of vacuum molded reinforced plastic sheet (F.R.P. 0.8 to 1.0 mm thick) with polyurethane film glued on it and external decorative cloth pasted on the plastic sheet. The decorative cloth is trimmed with beads, and those ceiling panels are set on the stringers and the frames with Velcro tape.

(2) Side Wall Panels

Panels of the side walls are also made up of vacuum molded reinforced plastic sheets (F.R.P. 0.4 to 0.6 mm thick) covered with fancy cloth. Joints of the panels are set in position with chrome plated retaining plates and screws.

(3) Decorative Cloth

The decorative cloth employed is a fire-proof material, Class 3 of TCT-4-002.

11.2.3 Partitions

Partitions are provided to divide the space above the floor into the cockpit, the passengers' compartment, the galley, the forward cargo compartment, and the aft cargo compartment. Of those partitions cited above, the partitions installed between the cockpit and the passengers' compartment, and between the front wall of the galley, the wall of the lavatory, and the front wall of the aft cargo compartment are fixed to the fuselage and therefore are not removable.

Between the cockpit and the passengers' compartment is provided a cockpit door made of honeycomb material and a curtain is furnished between the aisle and the passengers' compartment.

11.3 Cockpit Furnishings

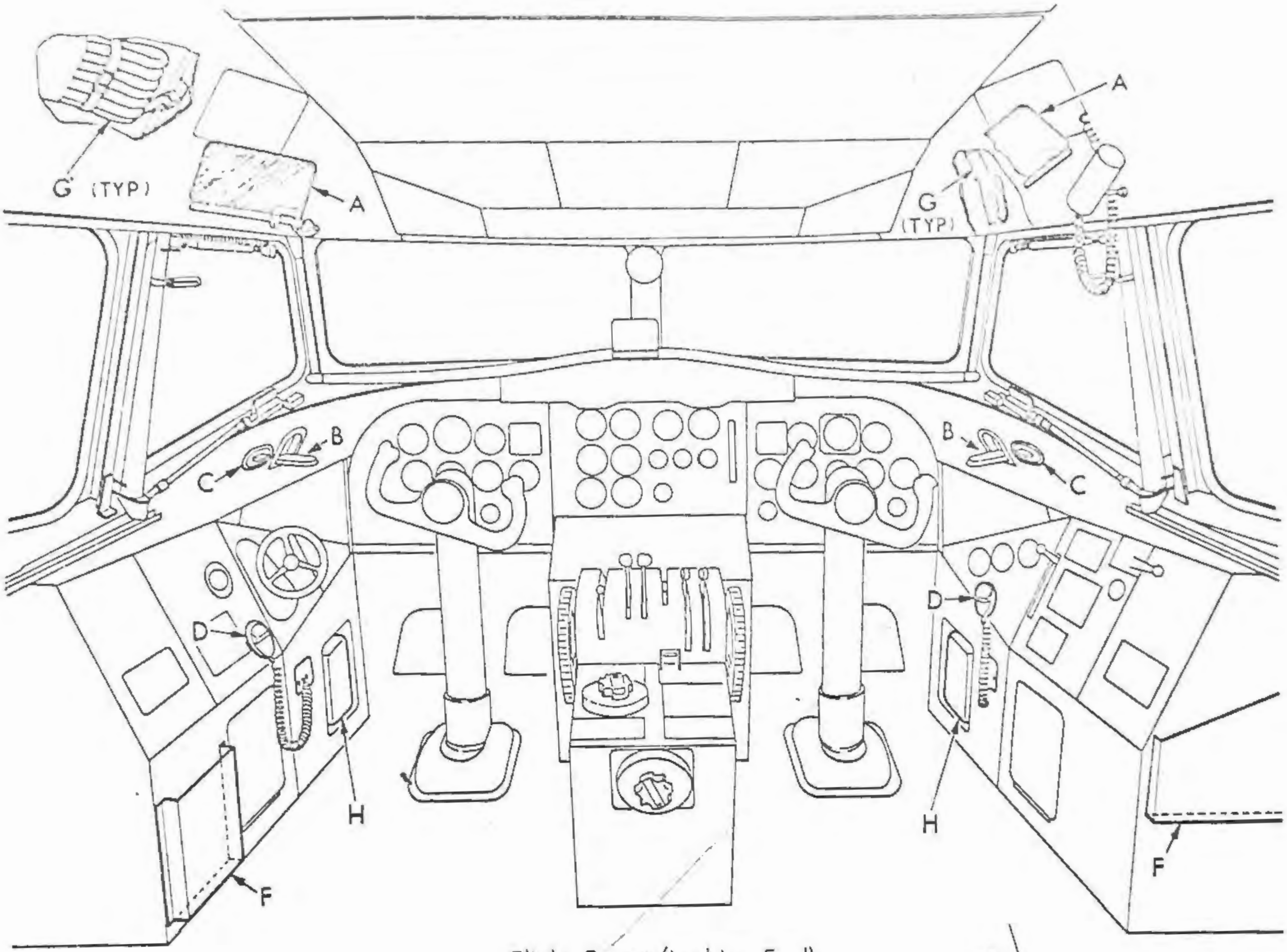
All equipment, apparatuses, meters, gauges, pilot lamps, etc. necessary for controlling the aircraft are provided in the cockpit, but the details will be found in their corresponding chapters also included herein. In this chapter, furnishings not covered elsewhere will be described.

(1) Sun Visors

Sun visors made of acrylic sheet are installed 1 ea. over the right and the left windshields respectively for the pilot and the copilot.

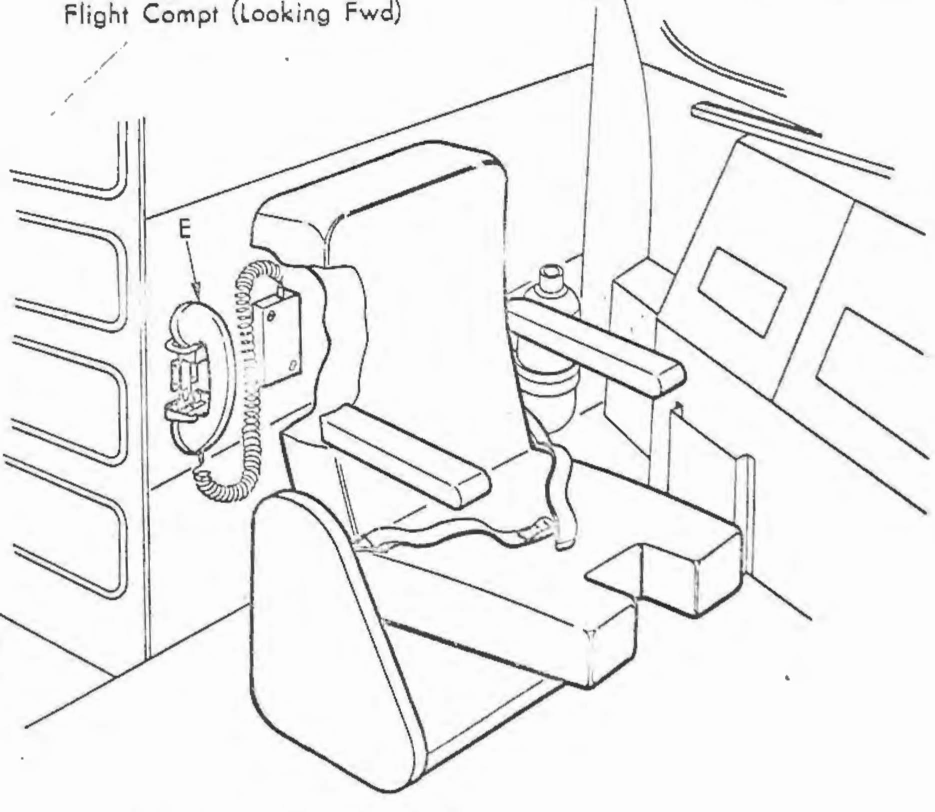
(2) Cup Holders

Cup holders made of reinforced plastic is installed with hinges, 1 ea. under the right and the left sliding windshields respectively, and they, when not in use, can be swivelled back into the wall.



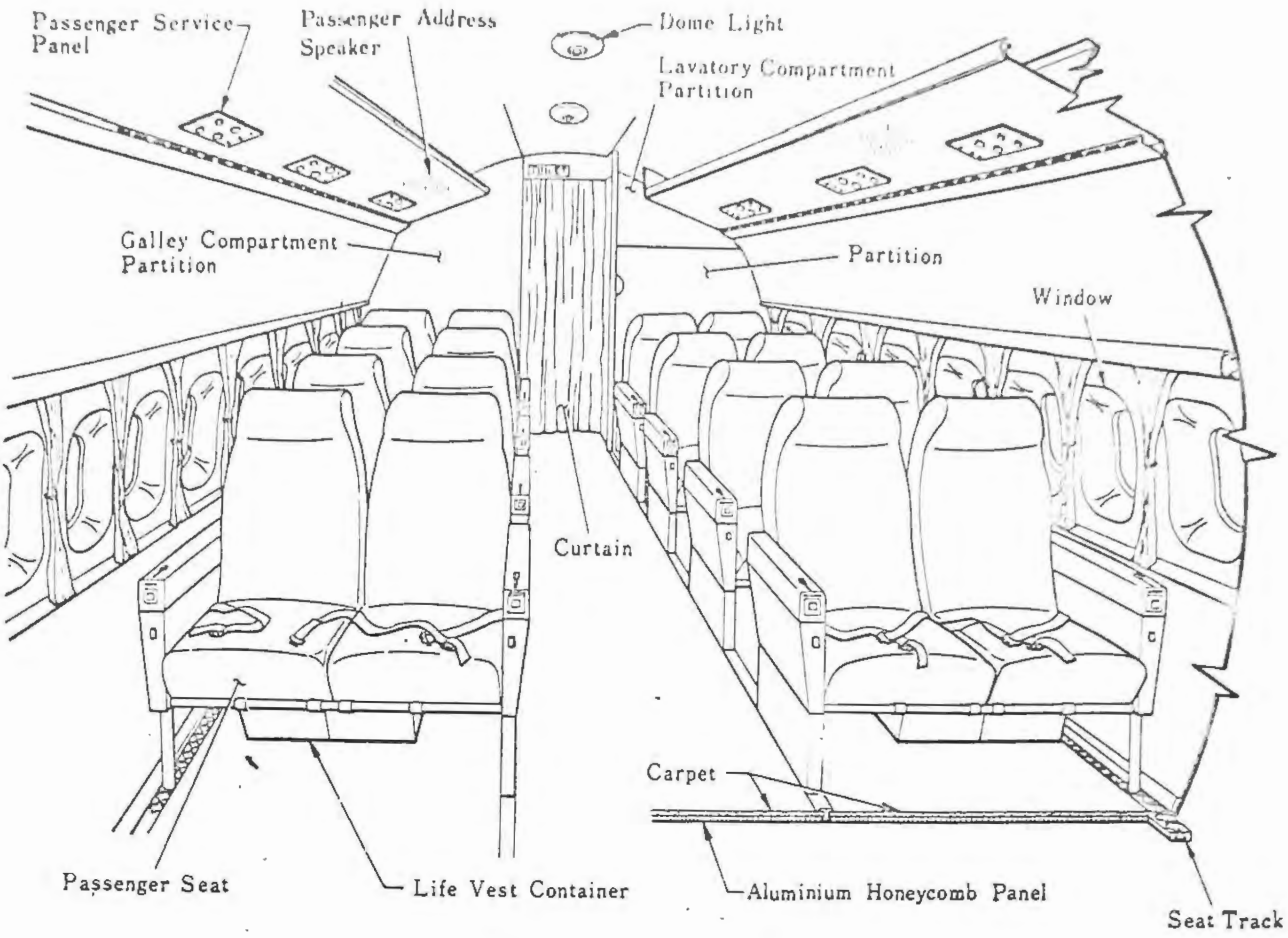
Flight Compt (Looking Fwd)

A	Sun Visor
B	Cup Holder
C	Ash Tray
D	Microphone
E	Hand Set
F	Mop Cose
G	Escope Lope
G'	Escape Lope (Applicable to #2029～2031 and 2038～)
H	Life Vest

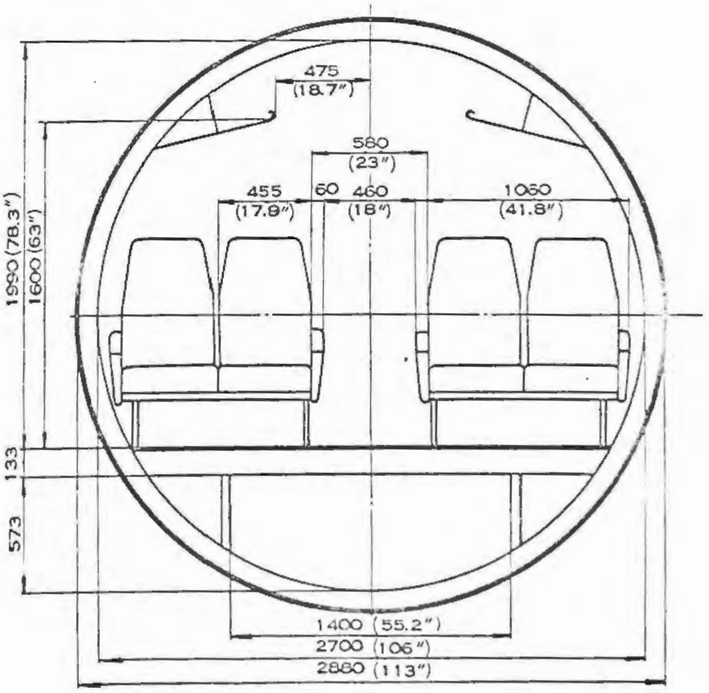


Flight Compt (Looking Aft)

Flight Compartment Miscellaneous Equipment
Figure 11–6


Passenger Service Panel
Passenger Address Speaker
Dome Light
Lavatory Compartment Partition
Galley Compartment Partition
Partition
Window
Curtain
Carpet
Passenger Seat
Life Vest Container
Aluminium Honeycomb Panel
Seat Track

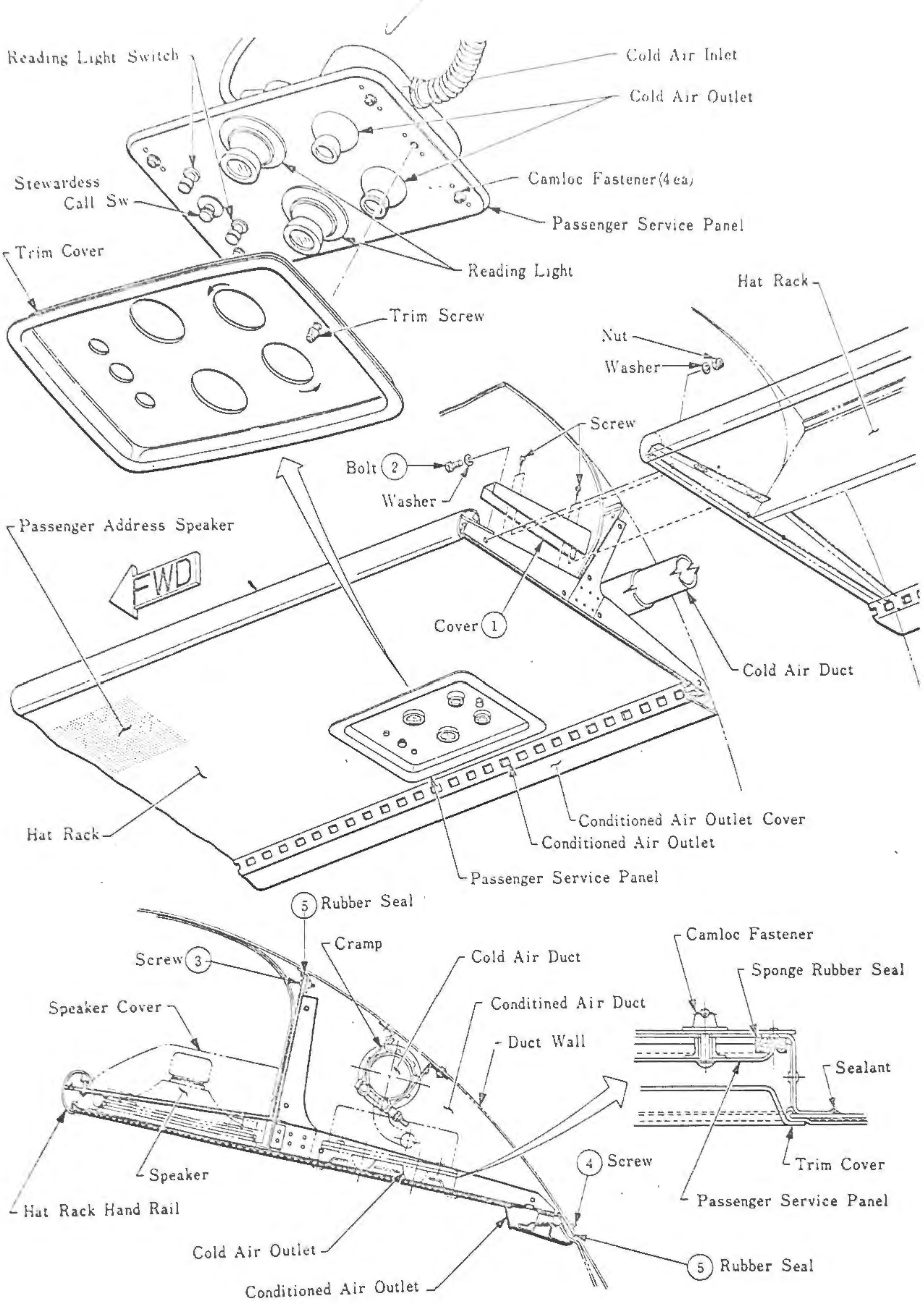
Passenger Compartment (Looking Aft)



Cross Section

Passenger Compartment

Figure 11–7



Hat Rack and Passenger Service Panel

Figure 11-8

properly as follows:

Bright .... all the lights are on
Medium .... one out of every two lights is on
Night .... only the incandescent lamps are on

11.4.4 Passenger Seats

Two persons can sit together and a collapsible arm rest is installed between the two adjoining seats. In the external right and left arm rests are provided the cup holders, ash trays, and reclining knobs.

(1) Cup Holder

It is composed of two arms which may be pulled out. They are held together with a spring provided inside, thereby enabling the arms to hold a cup in between. Both ends of the arms are so shaped that a cup may be held with ease.

(2) Ash Tray

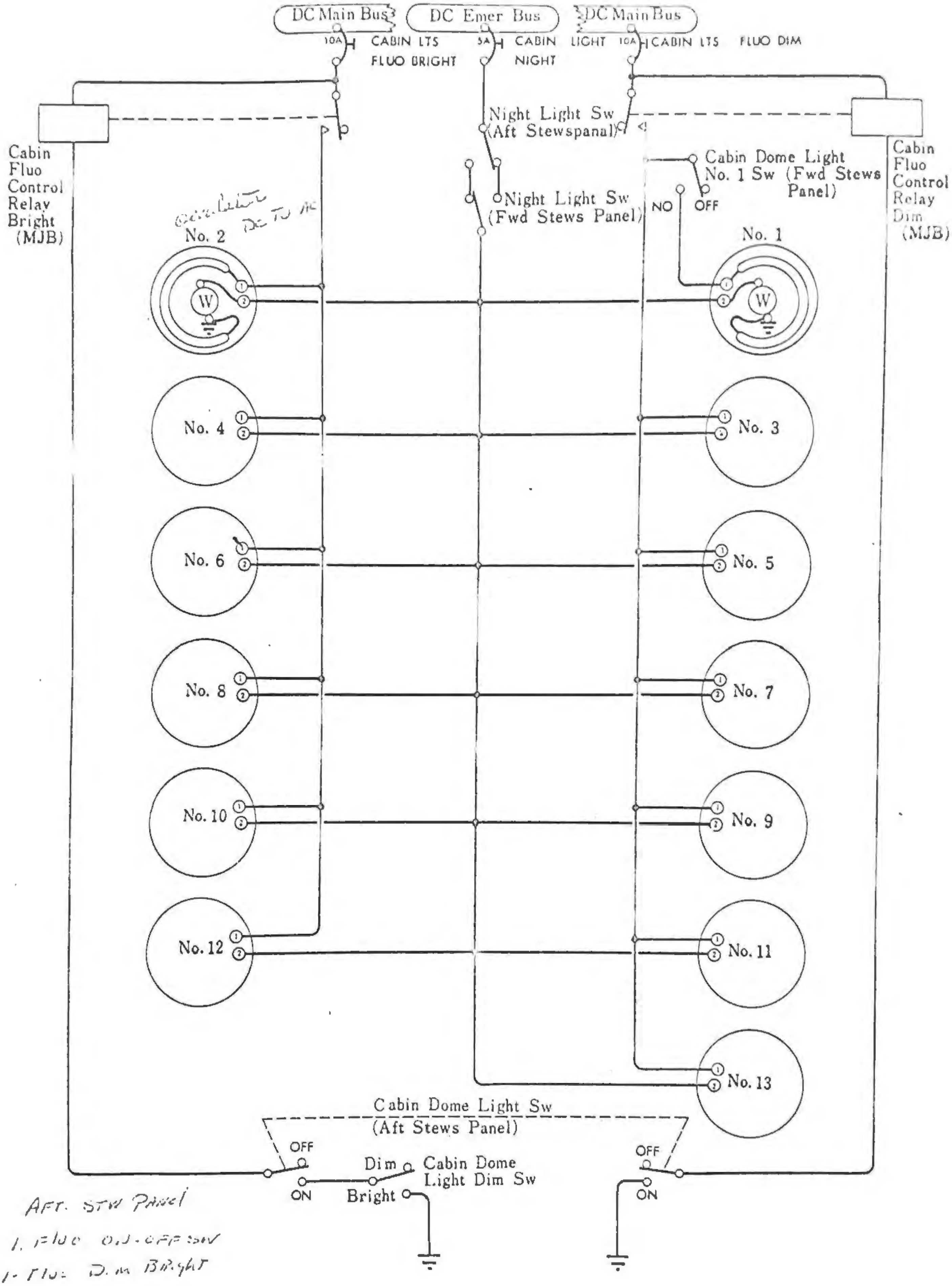
This ash tray is of pull-out type.

(3) Reclining Knob

By this reclining knob, the seat can be reclined between 15° to 29° as desirable. The backrest can be pushed rearward while pulling up the reclining knob. The reclined backrest can return automatically to its original position by releasing the lock by pulling up the reclining knob.

(4) Passenger Seat

The passenger seat which can be removed easily is mounted on railing with its legs and lock mechanism. Round holes are made on the railing at intervals of 24 mm, and the distance between the seat leg and the stopper is 36 mm. If the seat cover is removed, the cushion located inside can be taken out for use as a buoy type life preserver.



Cabin Lights Schematic Diagram

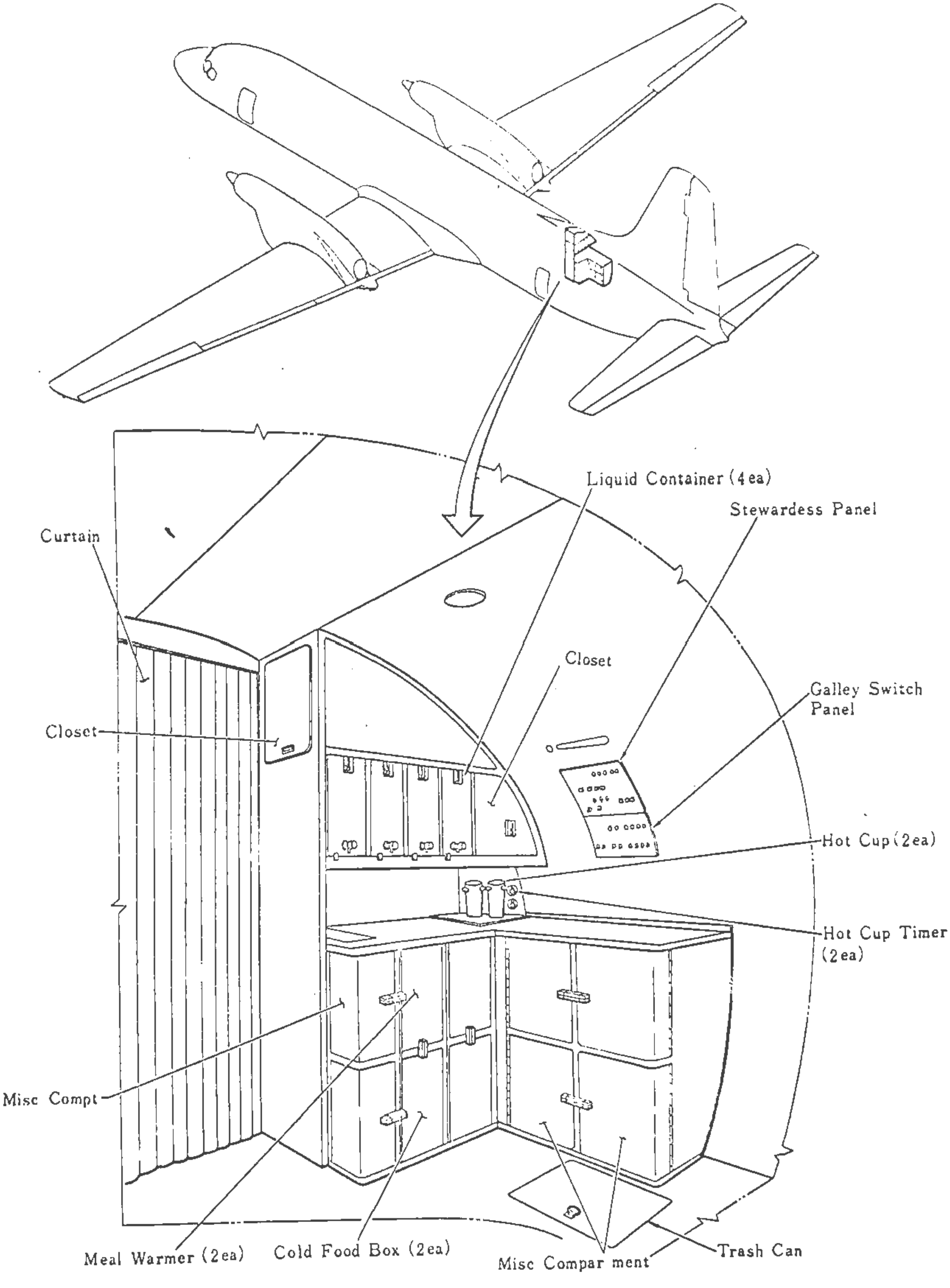
Figure 11-9

AFT. STW Panel
1. Fluo ON-OFF SW
1- Fluo Dim Bright
1 Night Light SW

Fwd STWD Panel
1 - Night Light SW.
1. Fluo ON OFF SW

Deleted

Figure 11-10



Galley Layout
Figure 11-11

11.5 Galley and Stewardess Seat

In the galley are provided liquid containers, a sink, hot cups, meal warmers, cold food boxes, storage shelves, etc. and underneath the floor is a trash can. Their leading particulars are as follows:

	Specification		
	Size	Quantity	Power consumption per unit
Liquid Containers	2 USG	4	120 watts
Hot Cups		2	480 watts
Meal Warmers		2	200 watts
Cold Food Boxes		2	200 watts
Misc. Compt.		4	
Trash Can		1	
Closet		1	

(1) Electric Power for the Galley

Electric power may be used in the galley under the following conditions only:

a. The aircraft is in flight with its two engines in operation .... W/F AC

b. The power distribution system of the aircraft is connected with the ground power source .... DC

Thus, electric heat can be used in the galley either when W/F (A.C.) is supplied in flight or when the ground power unit (D.C.) is connected to the aircraft on the ground.

The galley power selector relay in the elect. compt. is in operation when the GPU is connected and it is concurrently switched to the DC main bus bar and thus 28 volt DC is supplied to the switch panel in the galley.

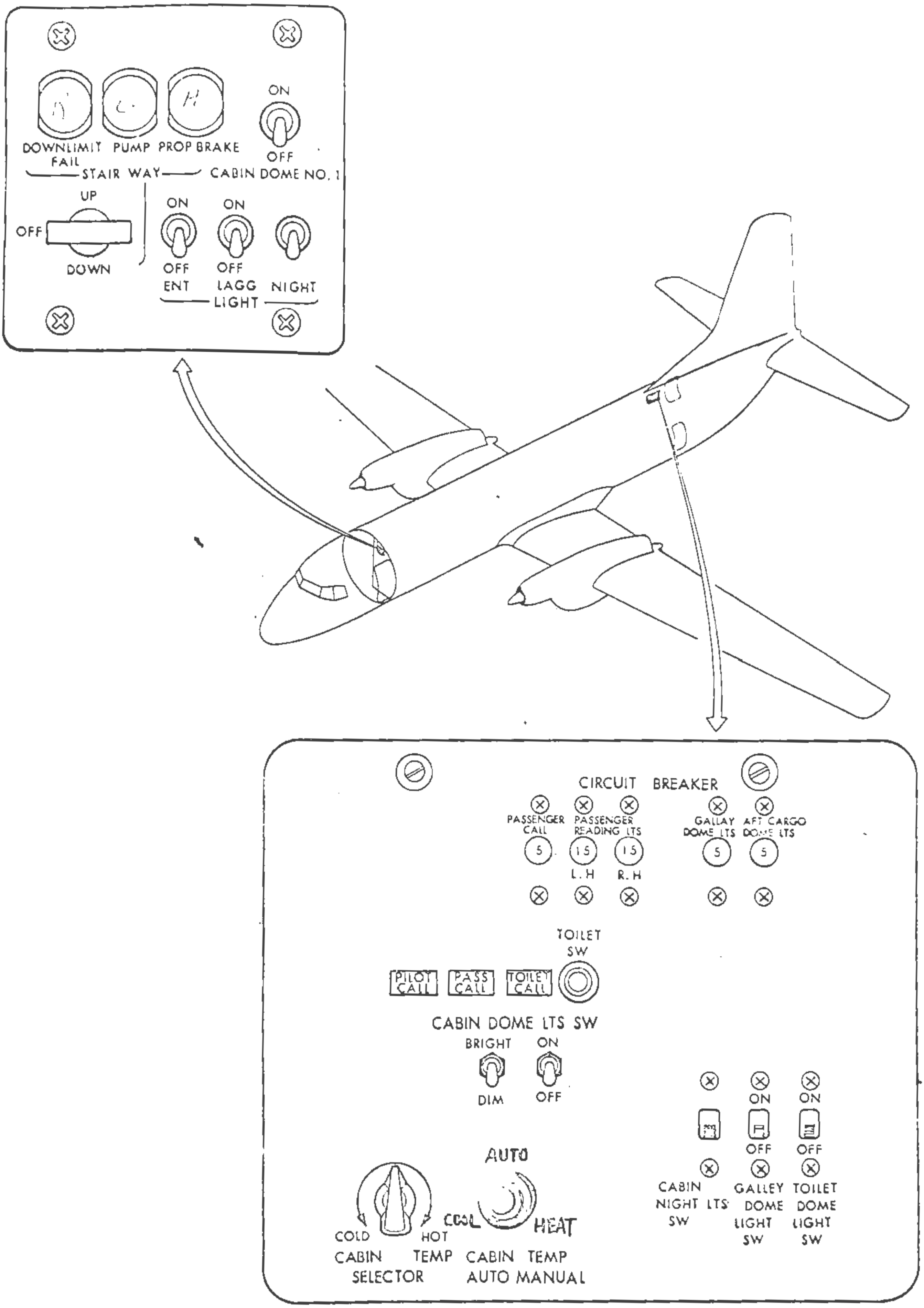
This power source is controlled by the aft stewardess panel switch and when the power is being supplied, the pilot lamp is on.

(2) Stewardess Panels and Galley Switch Panel

In the aircraft are provided two stewardess panels which are described below collectively.

a. Forward Stewardess Panel

The forward stewardess panel is found on the upper right hand side just inside the passenger entrance and is provided with the following five switches:



Stewardess Panel

Figure 11-12

Stairway control switch
Entrance dome light switch
Lagge light switch
Cabin night switch
Cabin dome No. 1 switch

The foremost cabin light is put on and off from this forward stewardess panel.

b. Aft Stewardess Panel

The aft stewardess panel is installed in the galley and has such switches and light as listed below. Below this aft stewardess panel is located the galley switch panel.

Cabin temperature selector
Cabin temperature auto-manual switch
Cabin dome light switch
Cabin night light switch
Galley dome light switch
Lavatory dome light switch
Stewardess call light

c. Galley Switch Panel

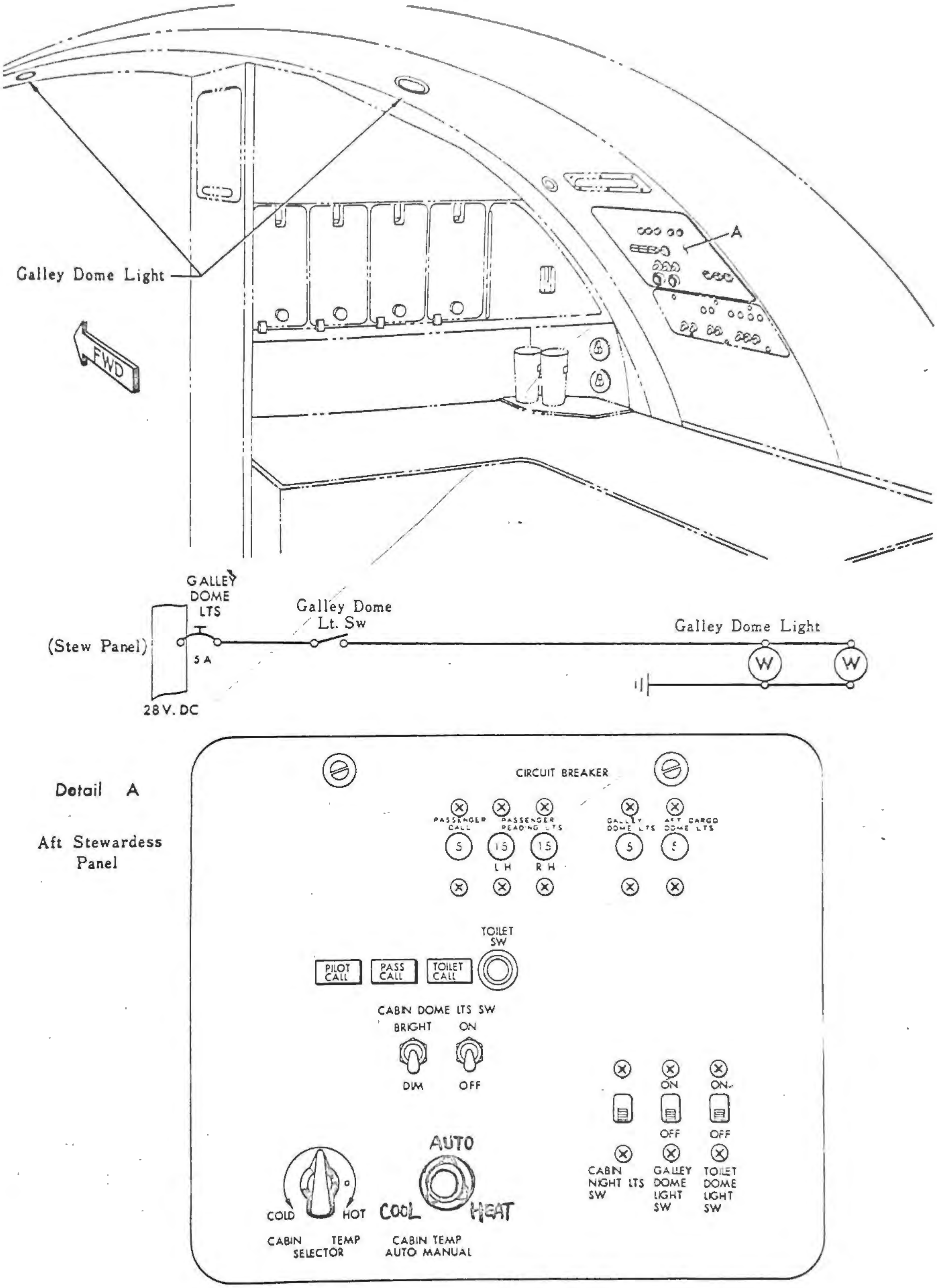
This galley switch panel is located beneath the aft stewardess panel and a galley power switch and pilot lamp are installed therein.

(3) Cabin Addressing Equipment

The stewardess handset station is located behind the stewardess seat on the wall that separates the galley from the lavatory, and cabin addressing and communication with the pilot are accomplished by means of this cabin addressing equipment.

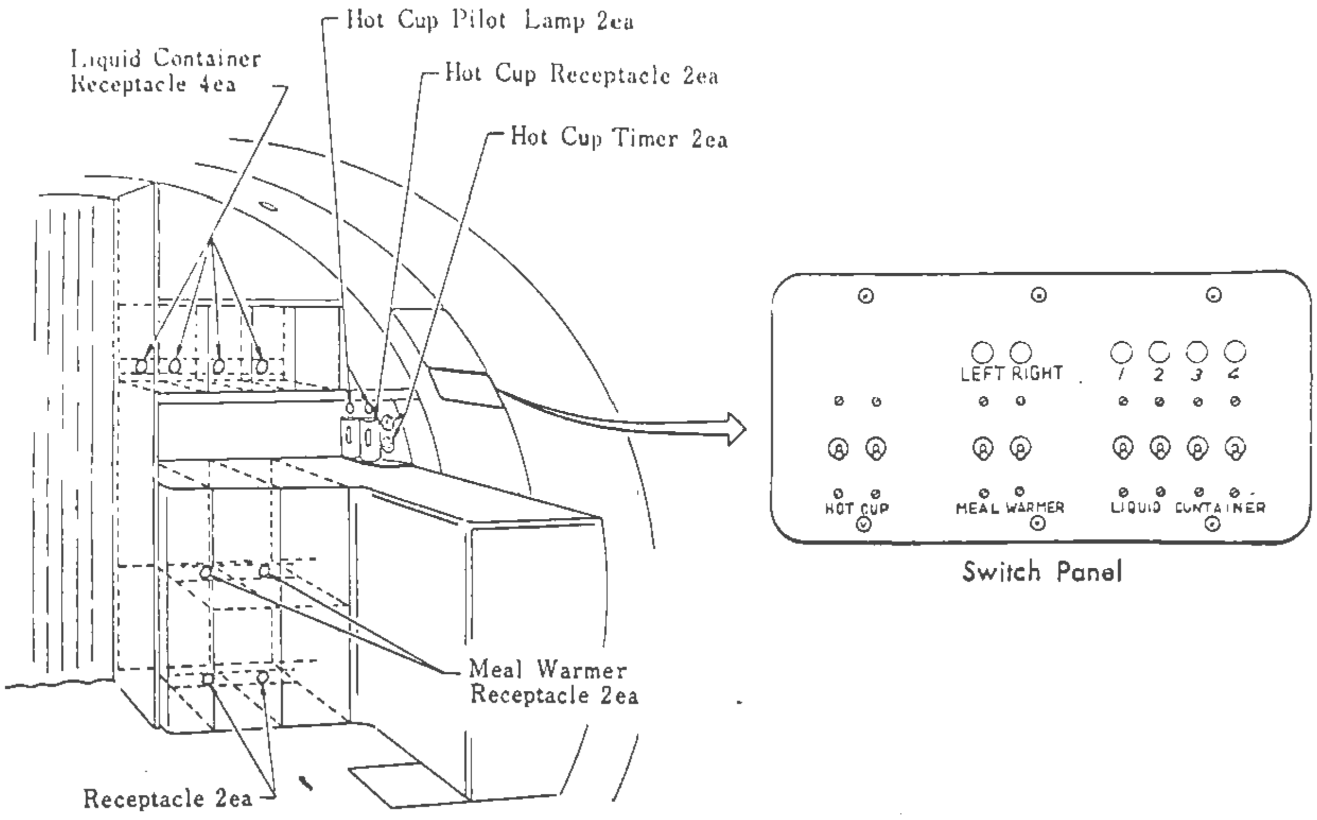
(4) Stewardess Seat

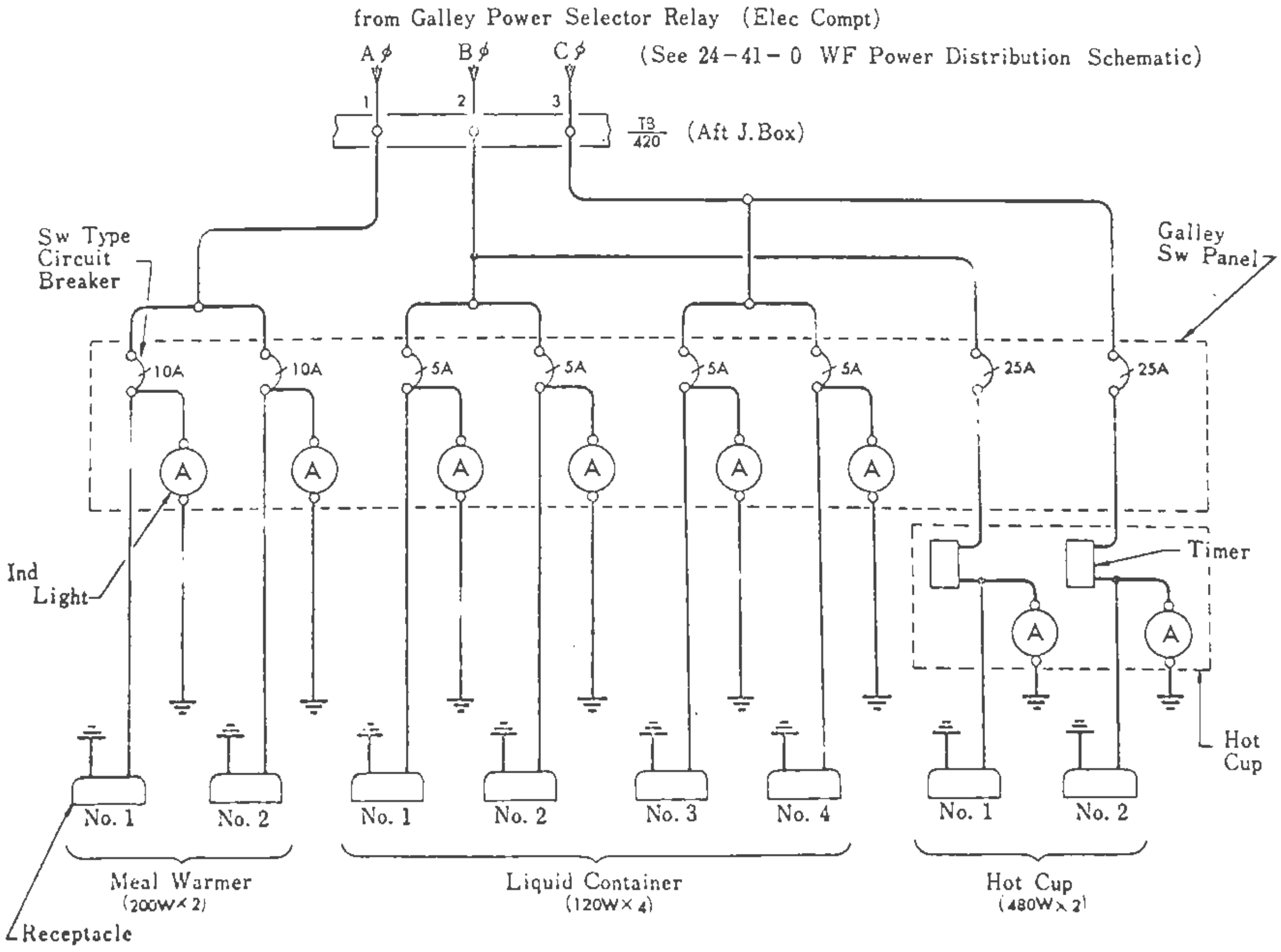
Two stewardess seats are located 1 ea. just inside the service door and in the galley near the lavatory. Those seats are set in place with hinges and are folded up automatically.



Galley Dome Light and Aft Stewardess Panel

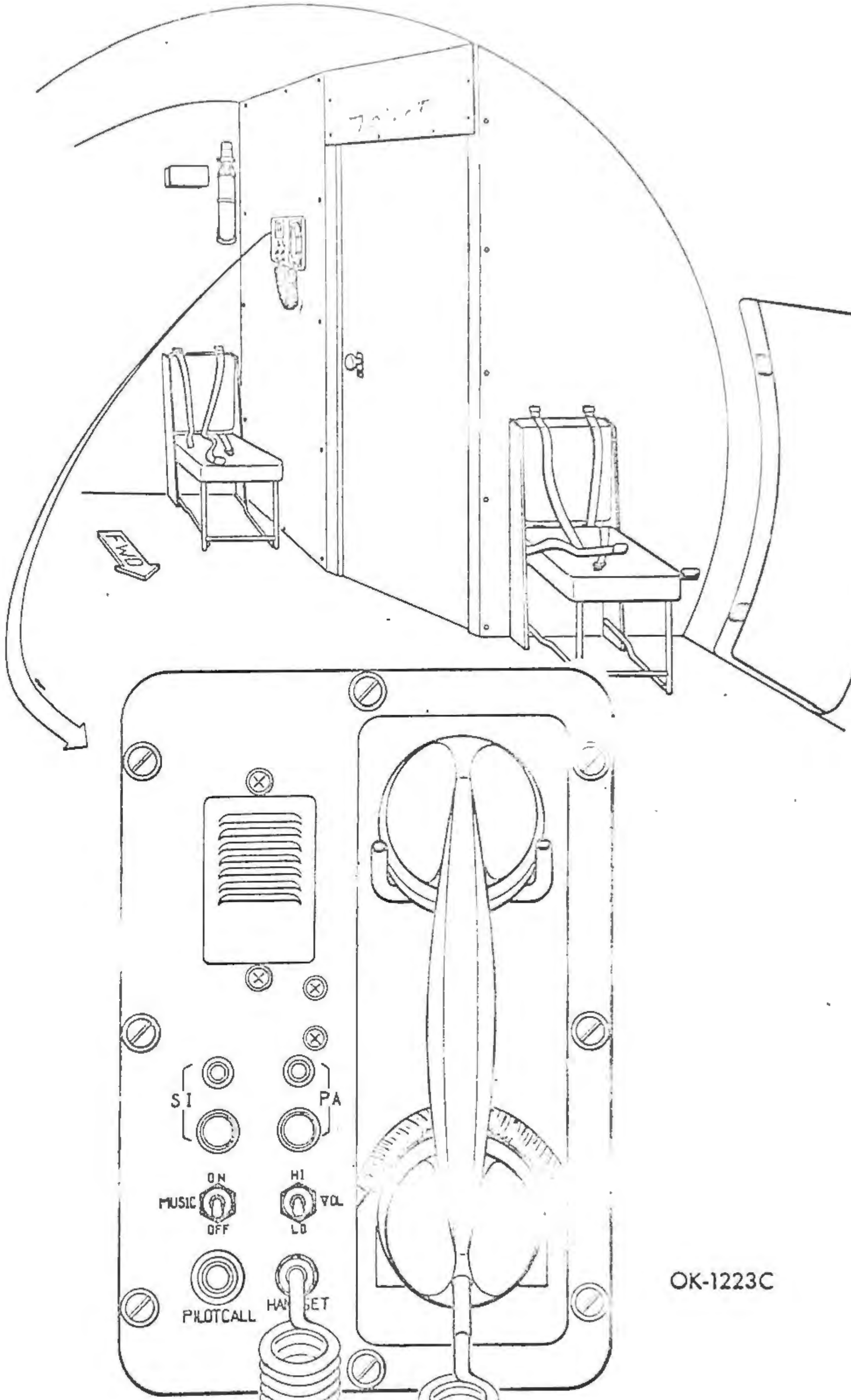
Figure 11-13





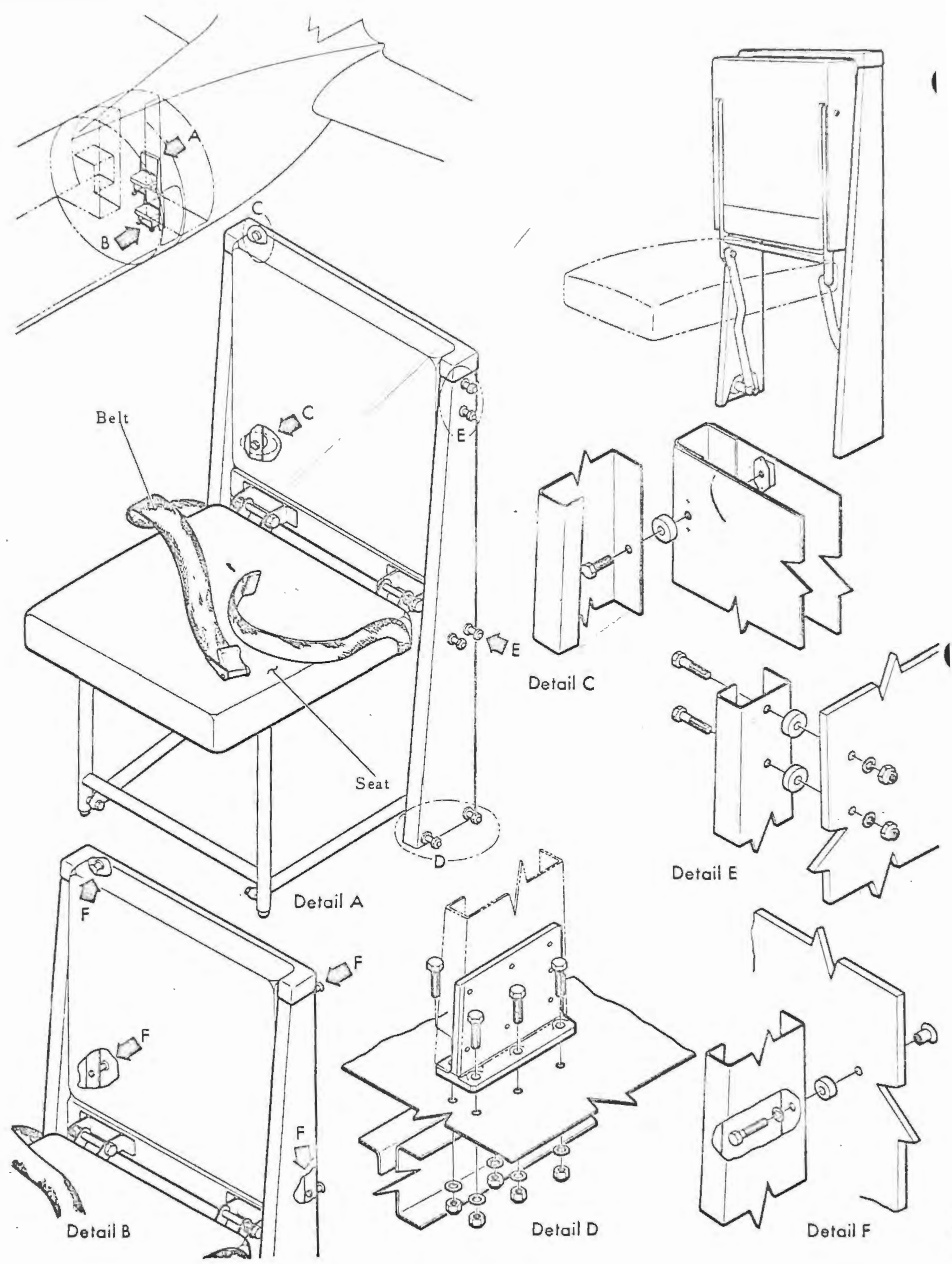
Galley Electrical Schematic

Figure 11-14

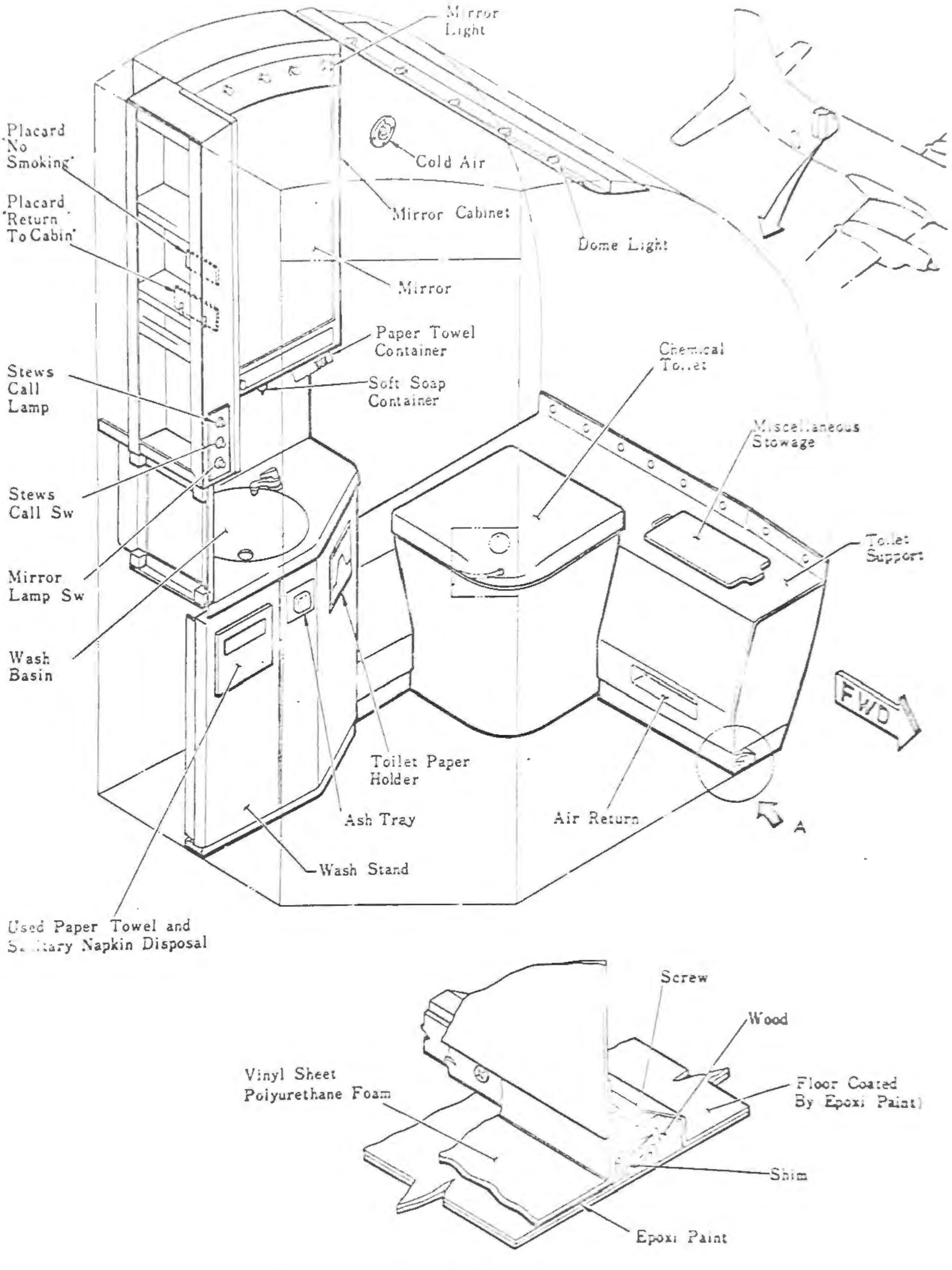


Stewardess Handset Station

Figure 11–15

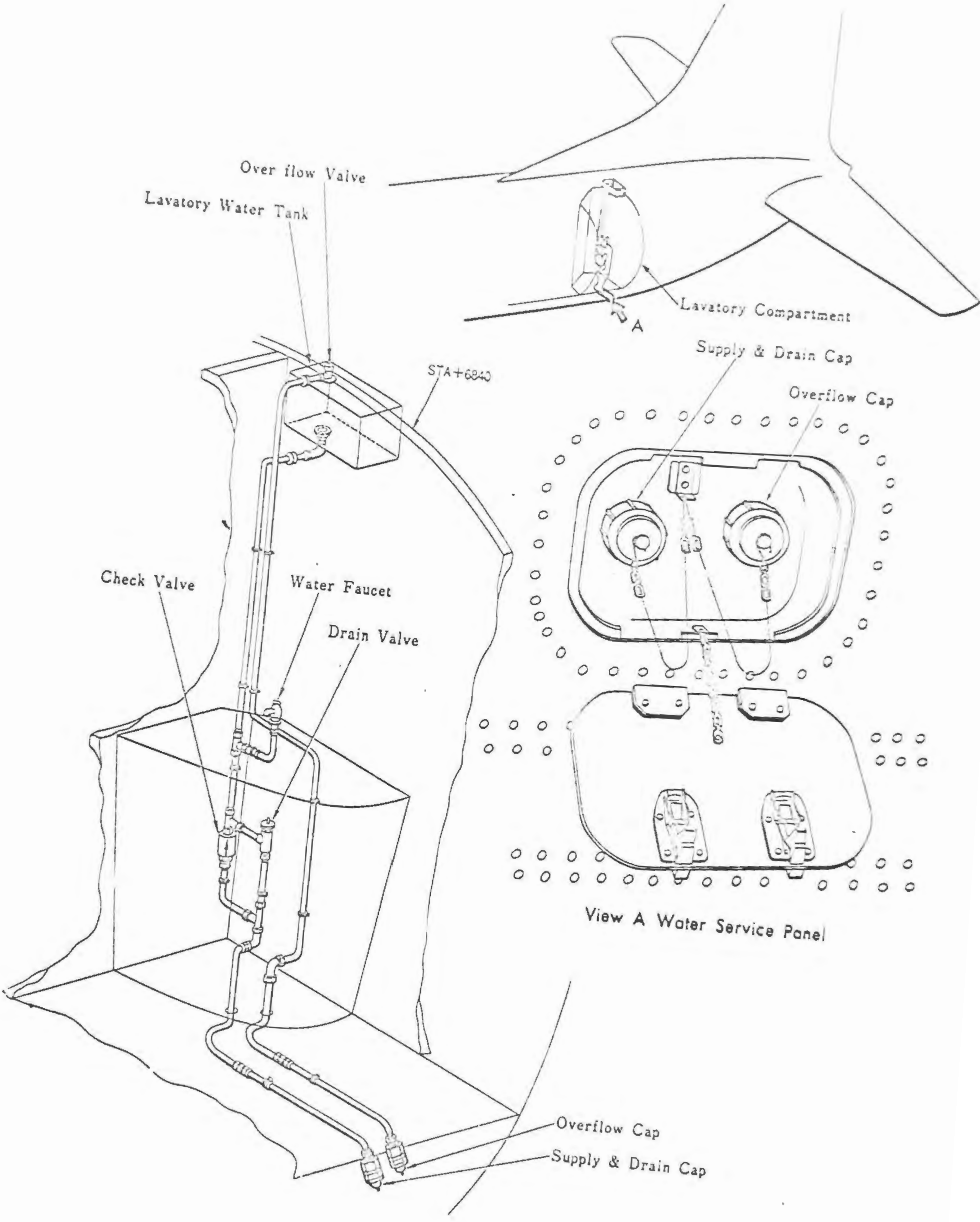


Stewardess Seat
Figure 11-16

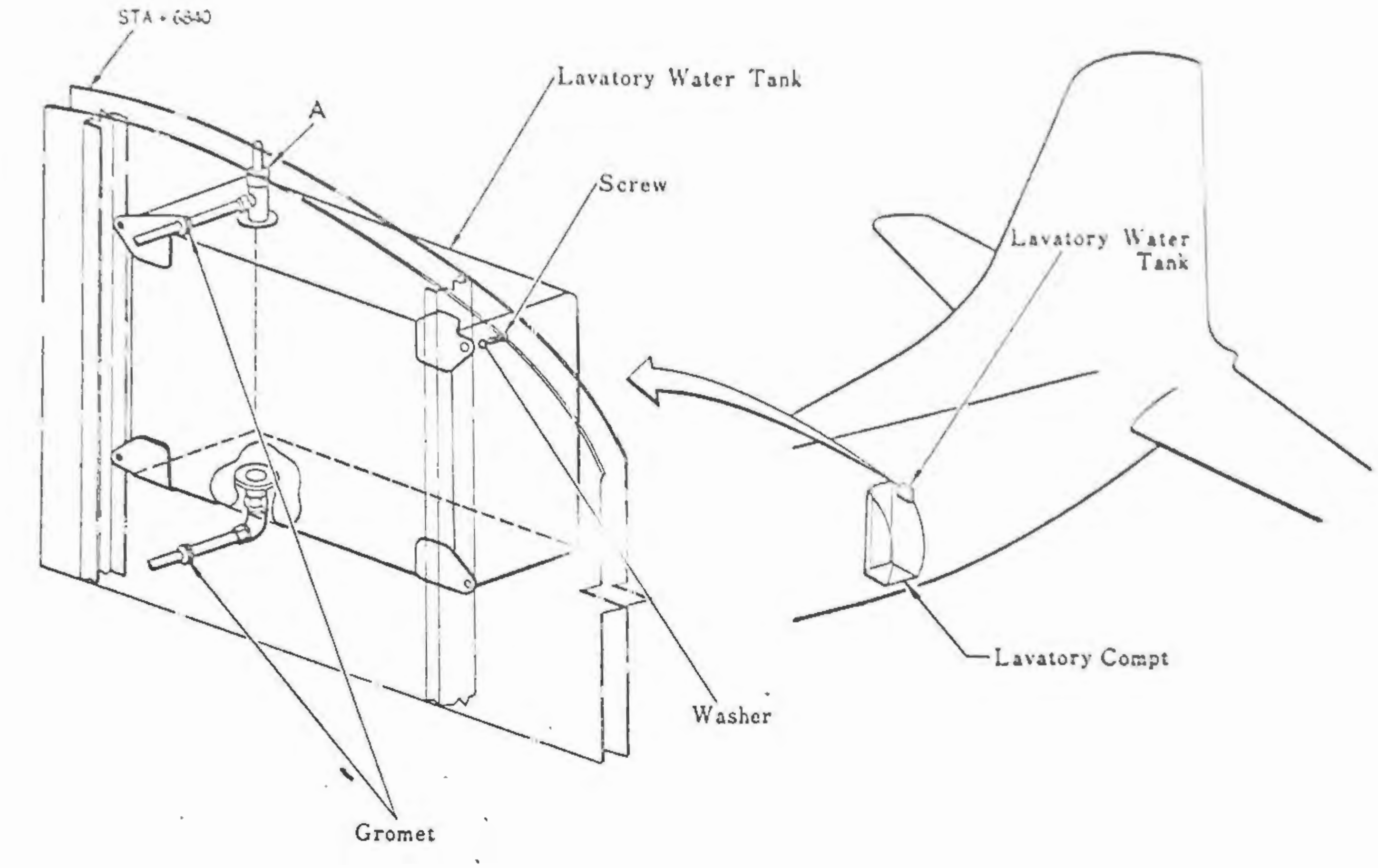


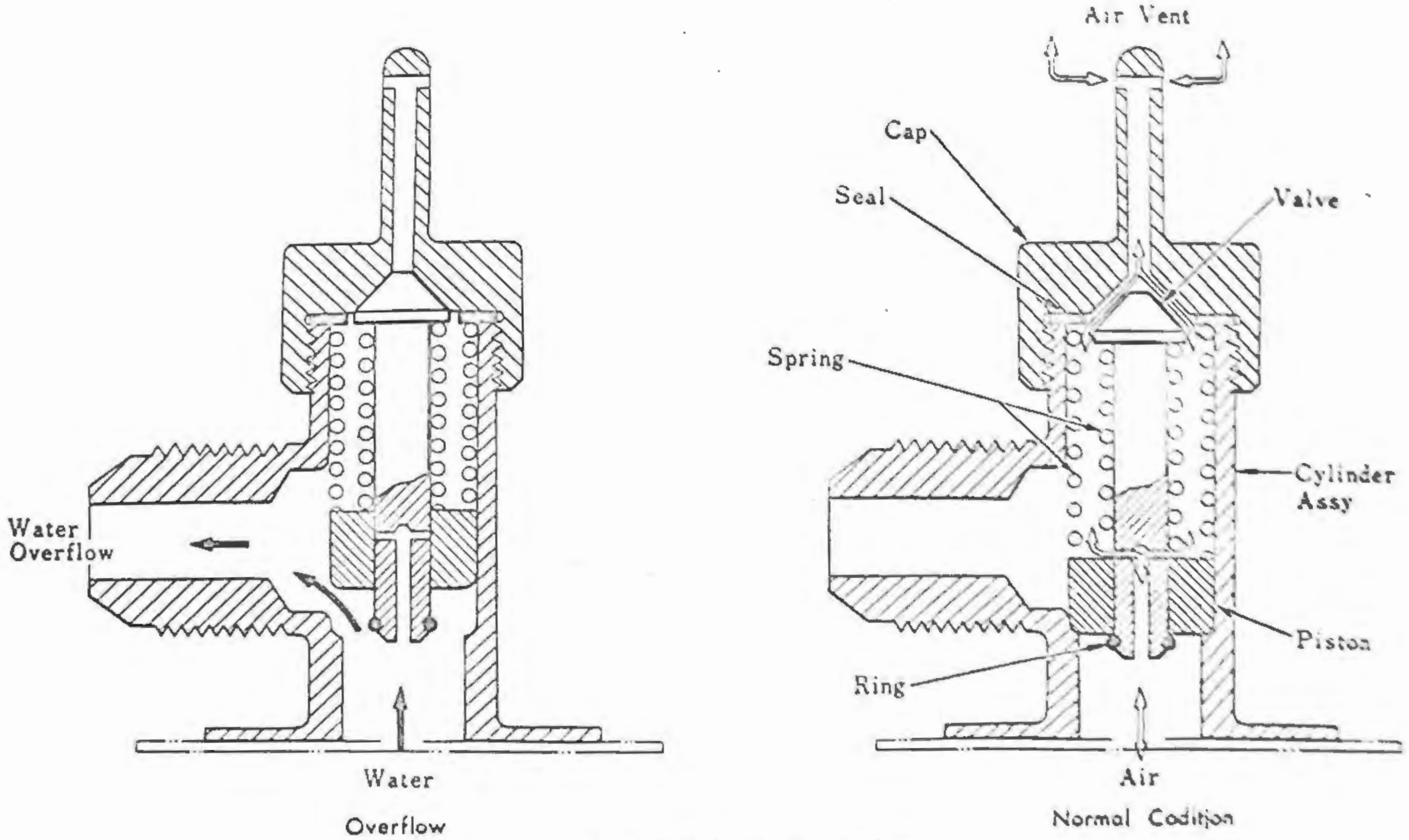
Detail A Lovatory Floor Corner

Lavatory Compartment
Figure 11-17



Lavatory Water
Figure 11–18

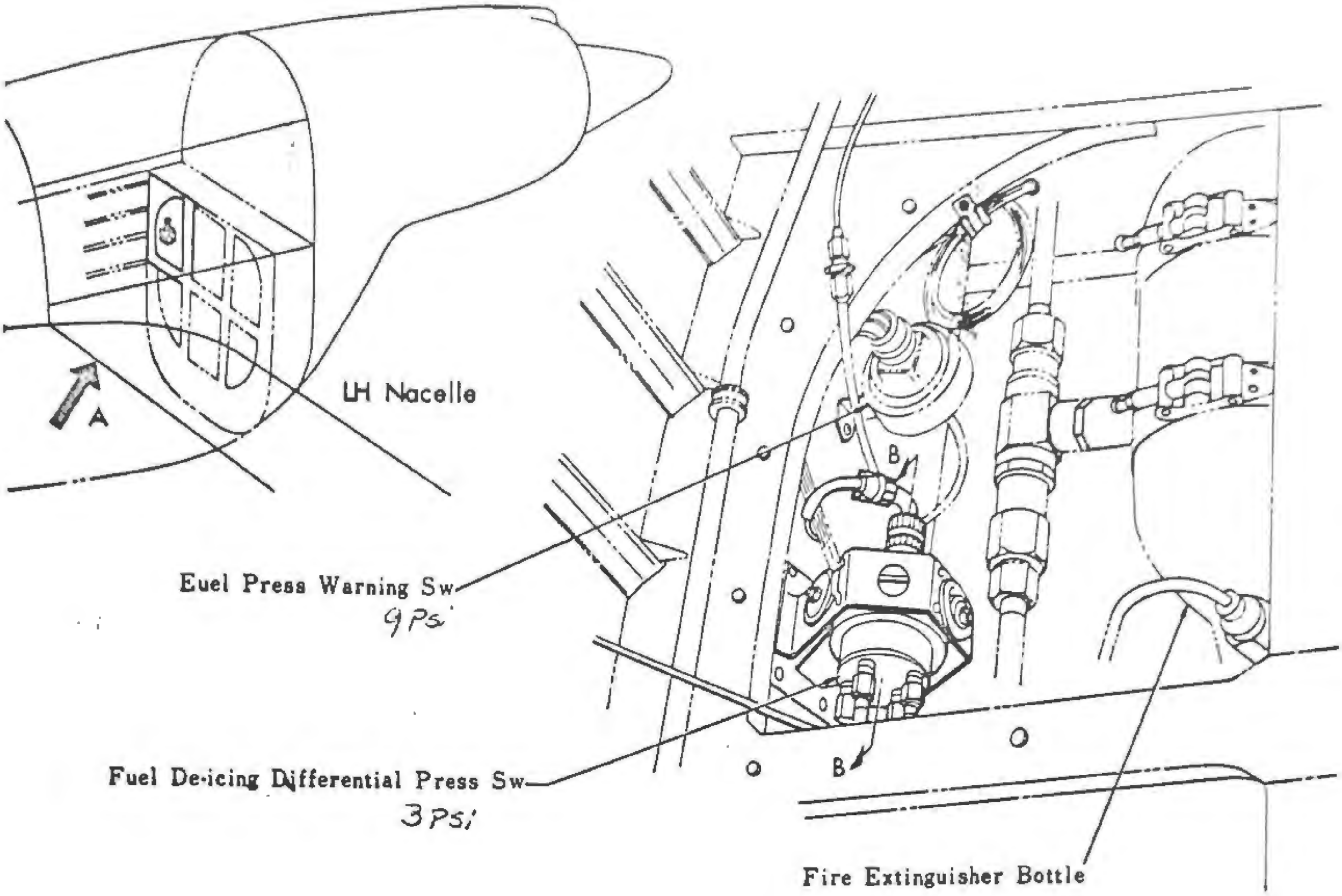




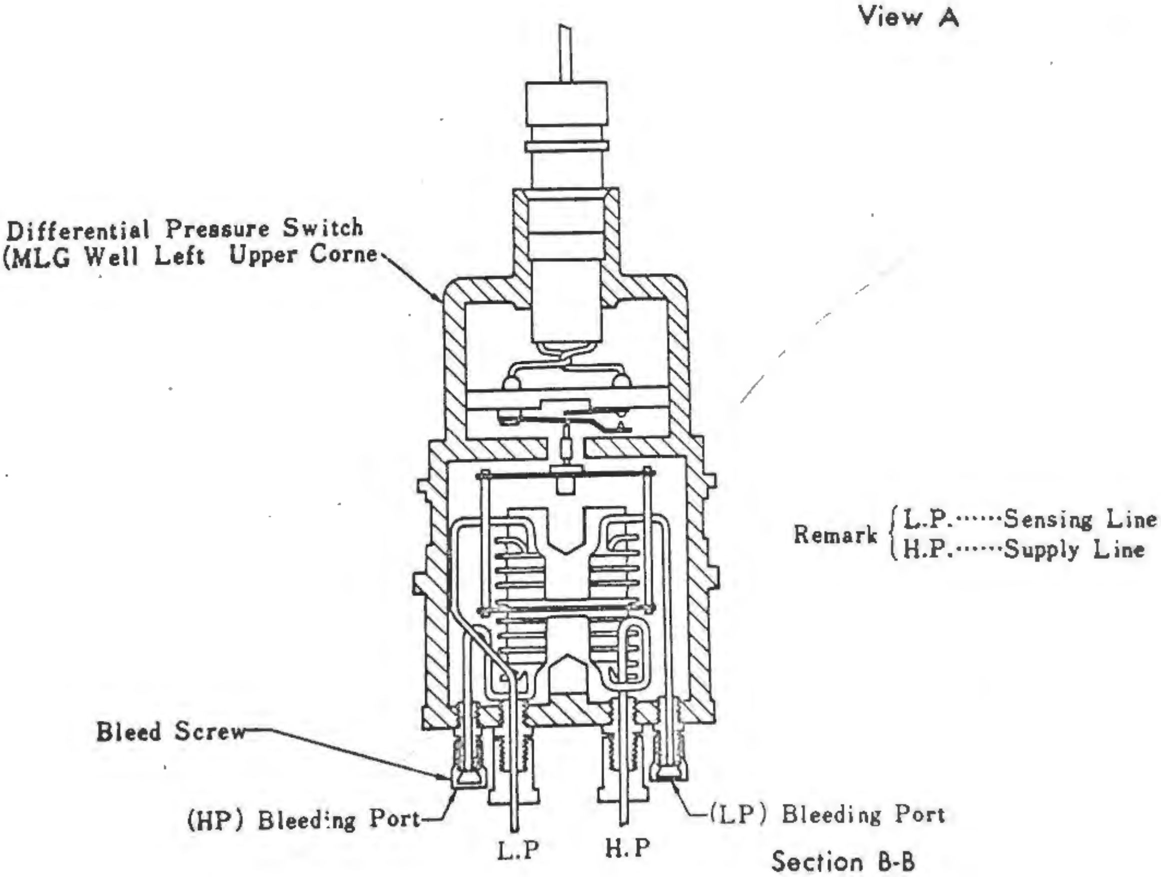
Detail A Overflow Volve

Lavatory Water Tank Installation

Figure 11–19

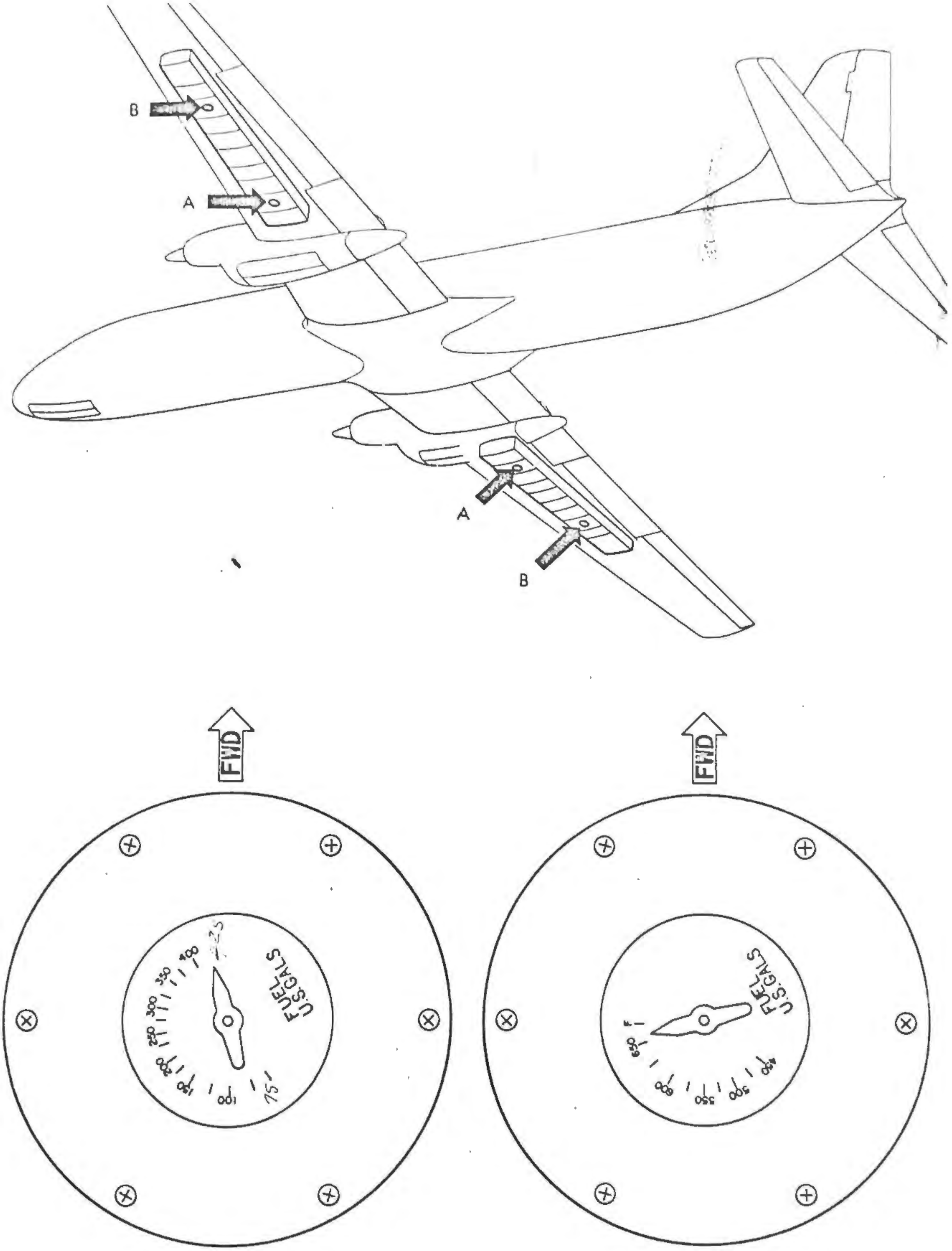


View A


Differential Pressure Switch
(MLG Well Left Upper Corne
Remark {L.P.······Sensing Line
H.P.······Supply Line
Bleed Screw
(HP) Bleeding Port
(LP) Bleeding Port
L.P
H.P

Section B-B

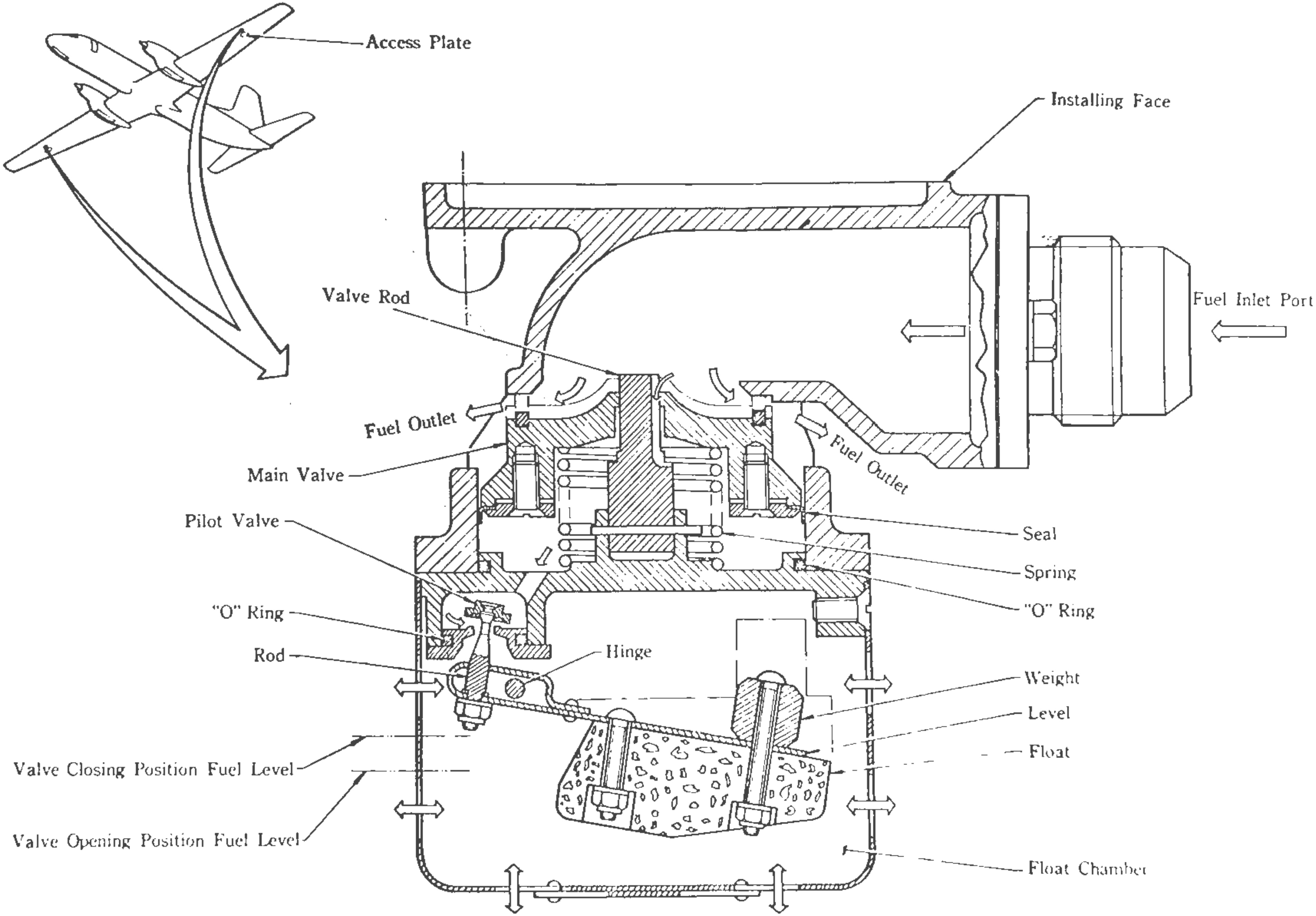
Fuel De-icing Differential Pressure Switch
Figure 5–32



A.Inboard Sight Gage

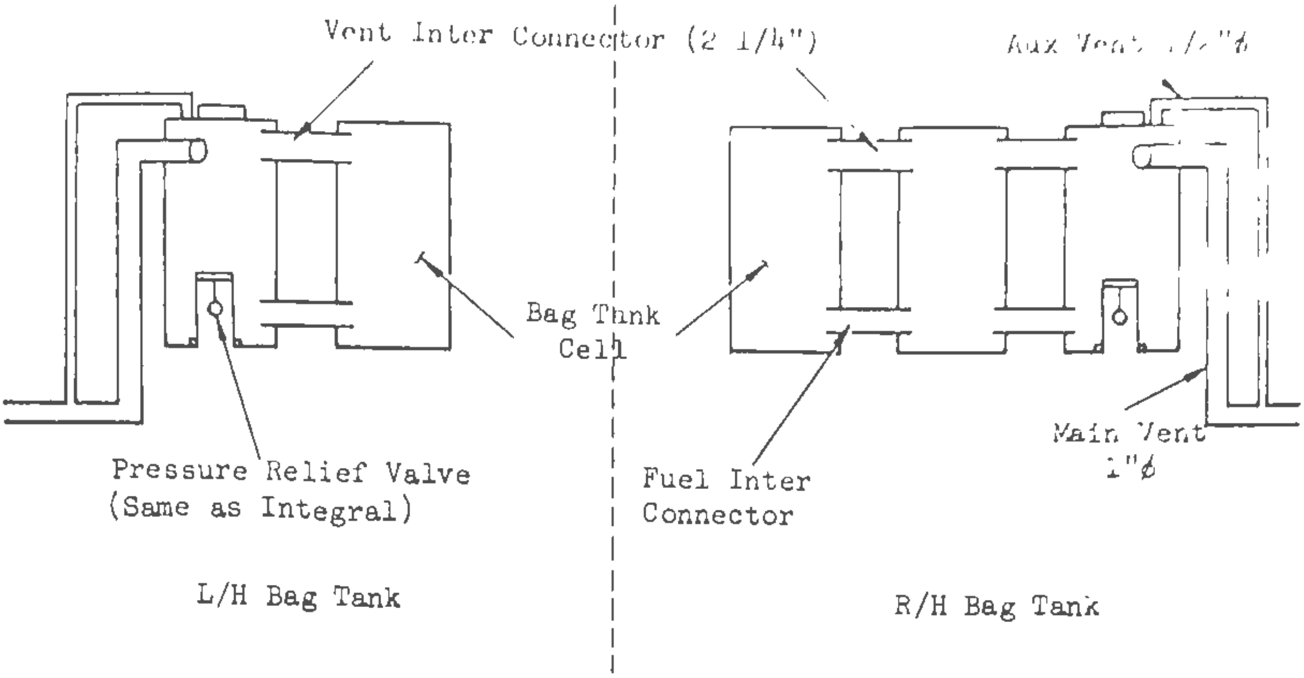
B.Outboad Sight Gage

Fuel Tank Sight Gage Installation
Figure 5–33



Level Control Valve Section View

Figure 5-33C



L/H Bag Tank

R/H Bag Tank

Figure 5-33D

5.8.5 Bag Tank Accessories

Fuel transfer pump installed on the mount at the bottom of the cell. The fuel quantity indicating transmitter and compensator, and float switch for pressure refueling comprise the bag tank accessories. The pressure relief valve is installed in the outside bag tank.

Construction and functions of above-mentioned accessories are the same as those mentioned already and explanation on these accessories is omitted here.

5.8.6 Fuel Quantity Indicator

The fuel quantity indicator in the cockpit, used in common for both integral and bag tanks, is designed to be selected by means of the selector switch. However, when bag tanks are not equipped, the following units are not provided and their connections are blinded.

(1) Selector Switch

(2) Tank Empty Warning Light

(3) Transfer Pump Switch

5.9 Water/Methanol System

5.9.1 General Description (See Fig. 5-35)

Engine output varies with atmospheric temperature. The water/methanol system of this aircraft is designed to inject water-methanol into the first stage impeller of the engine compressor to keep the maximum engine power 3,060 HP necessary for take-off by lowering the temperature and increasing the density of intake air as long as the outside air temperature variation remains within the range from -20°C to I.S.A. + 30°C.

Water/methanol delivered under pressure from the tank by means of the booster pump is metered to the desired quantity by the engine water/methanol metering unit.

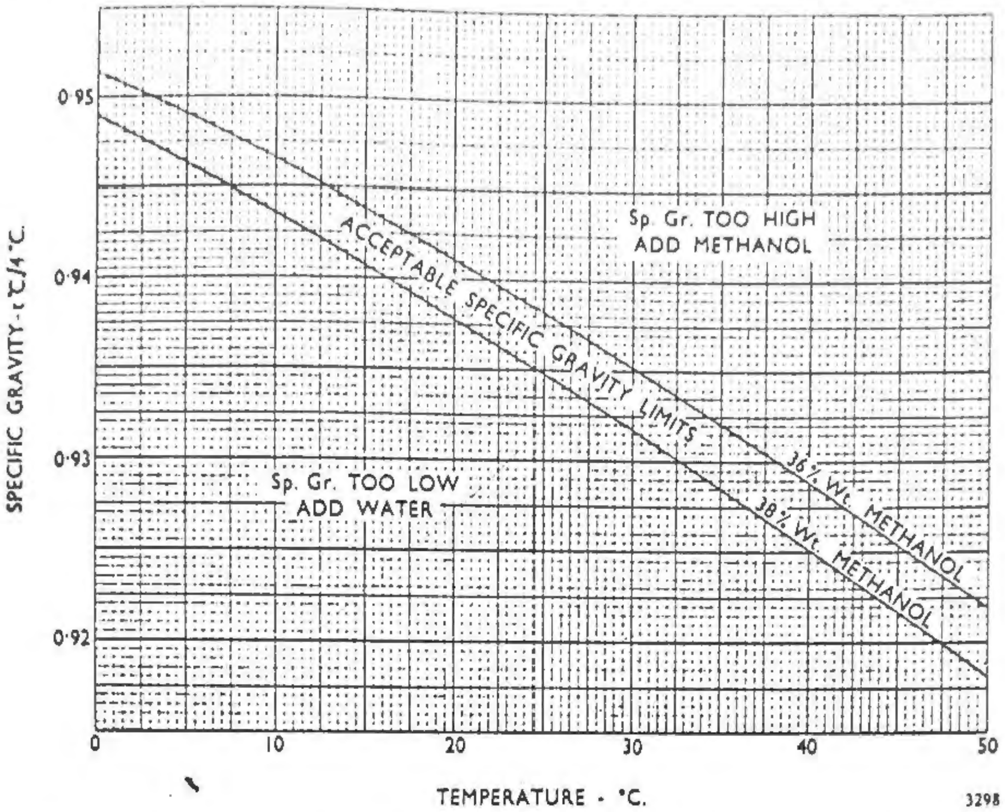
NOTE: As to the engine water/methanol metering unit and the water/methanol control unit, see Chapter 4, POWER PLANT.

5.9.2 Water/Methanol Tank (See Figs. 5-36, 5-37 and 5-38)

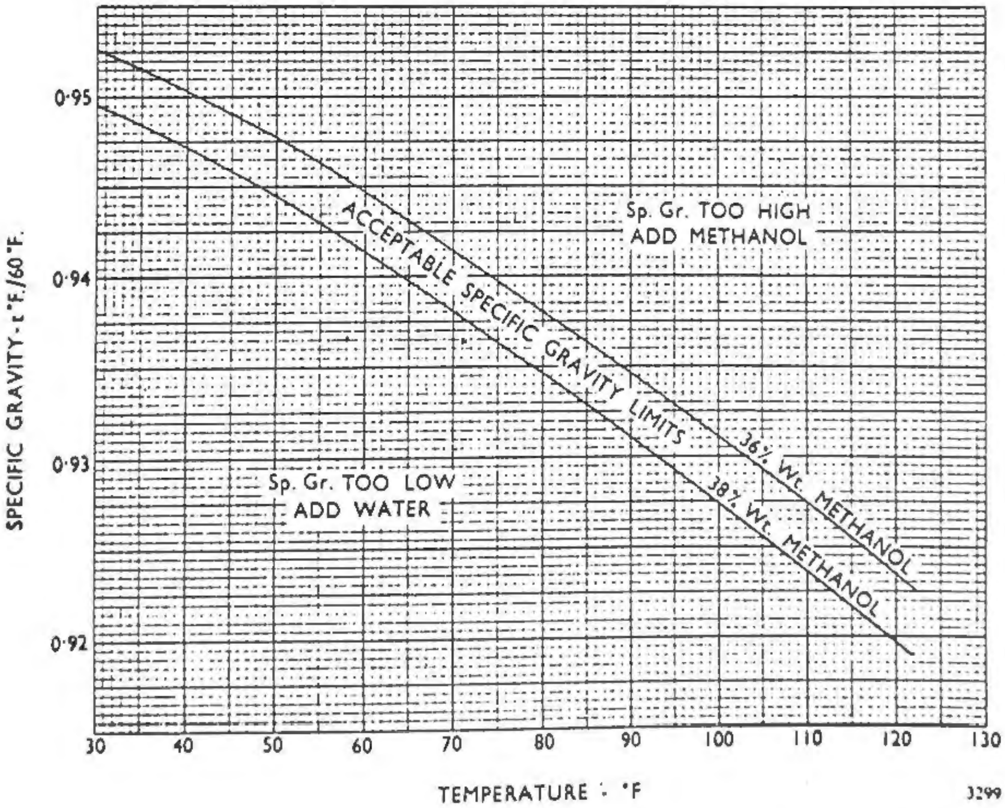
A synthetic rubber bladder type tank is installed in a cavity between the front and rear spars of the left outer wing, from W. STA 400 to W. STA 1,100.

The tank is fastened in the cavity by snap fasteners to the ceiling and by button fasteners to the side wall.

On the top of the tank is installed the filling port and at the bottom of the tank is installed the mount for pump installation. The main line and auxiliary vent line are attached to the tank.

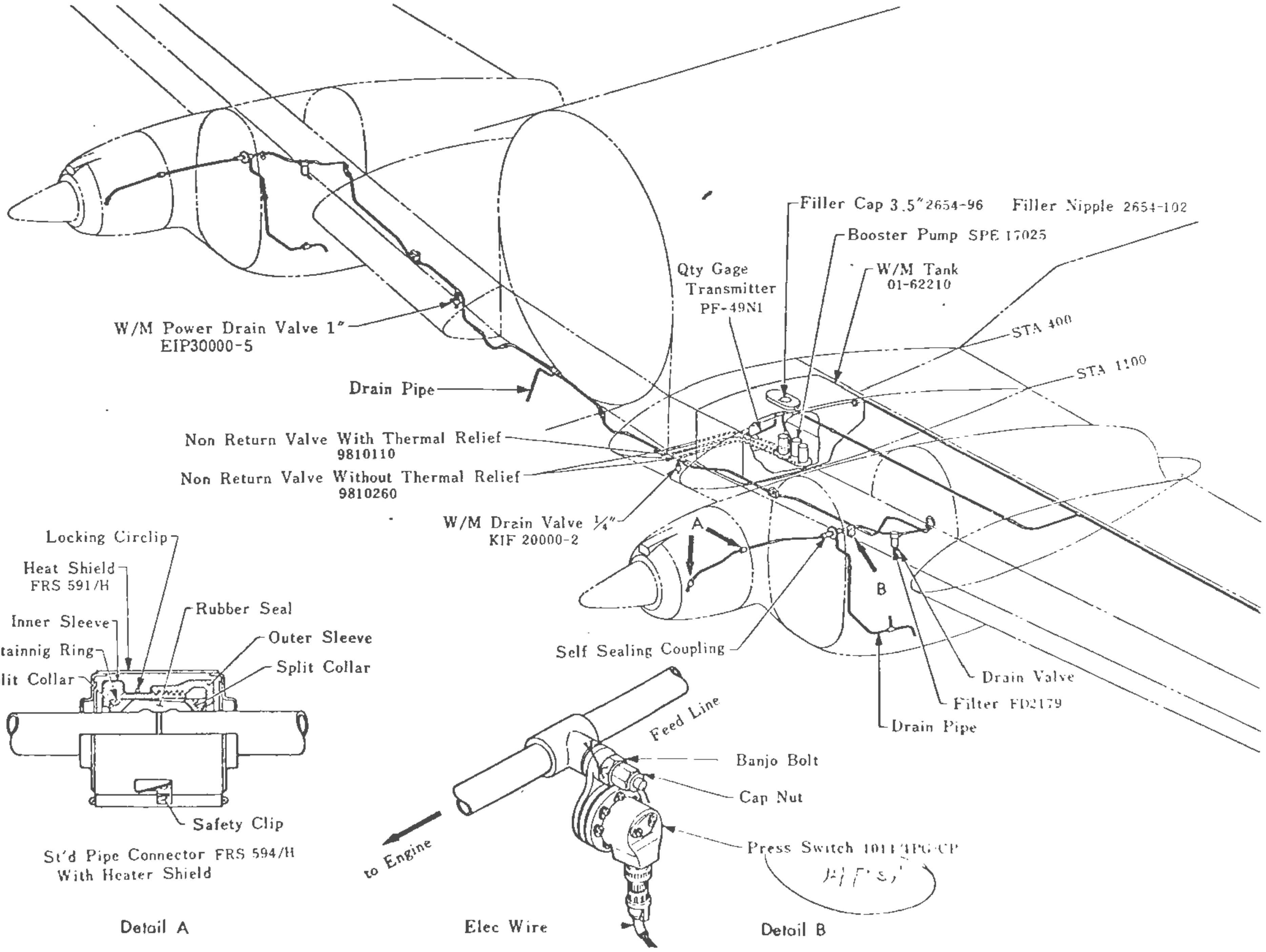


Specific gravity of water/methanol mixtures at various temperatures (Centigrade scale)

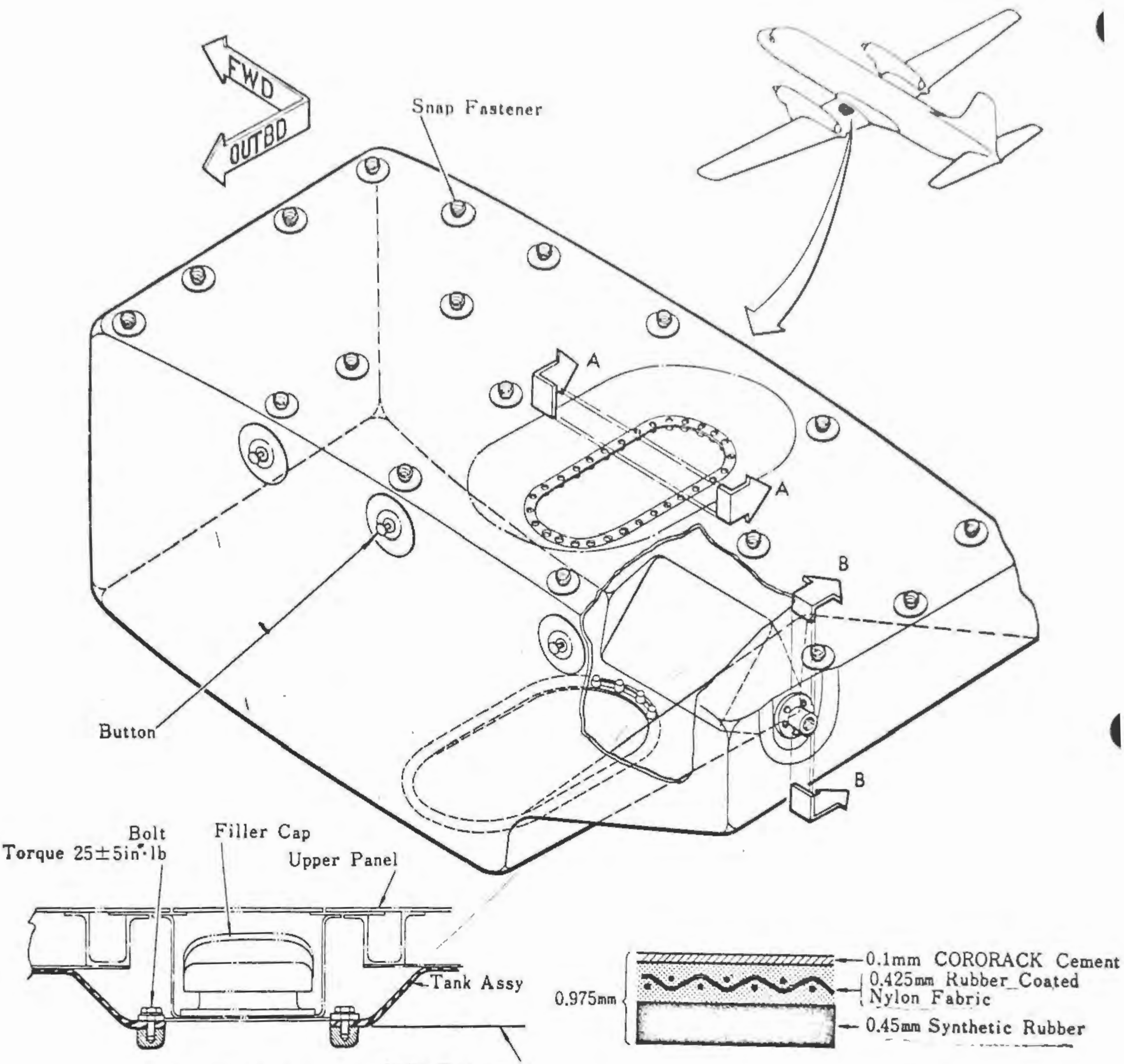


Specific gravity of water/methanol mixtures at various temperatures (Fahrenheit scale)

Figure 5–34

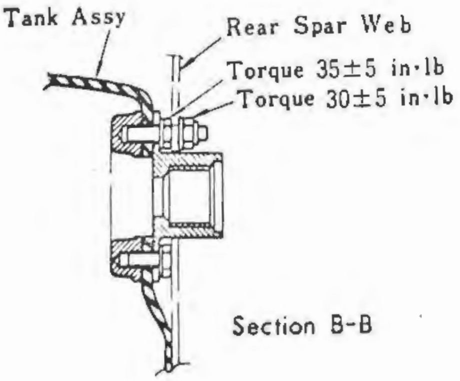


W/M System General Arrangement
Figure 5-35



Section A-A

Rubber Section



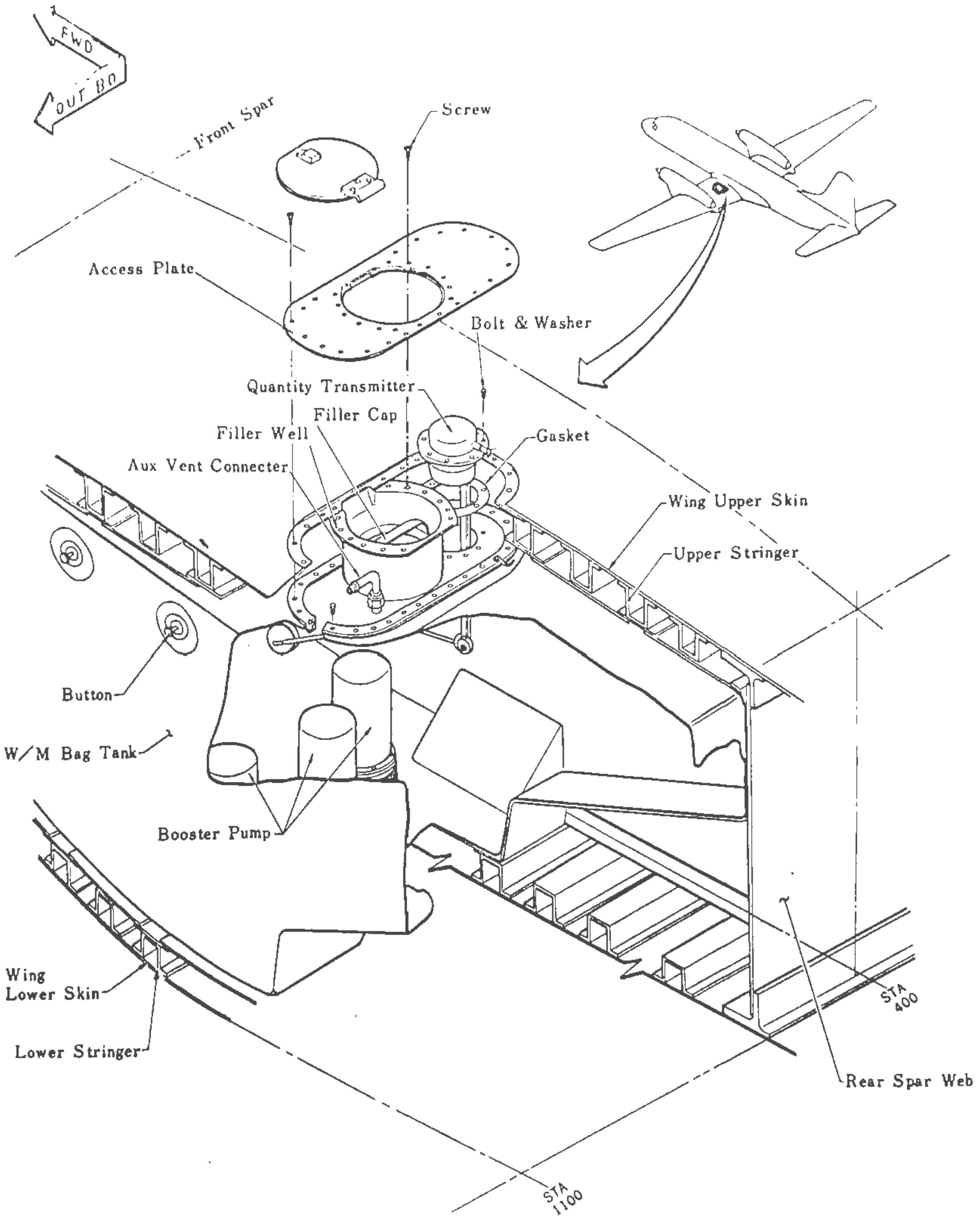
Section B-B

Note :

1. May be used the tank if no leakage at 0.5psi
2. Not use the bolt that is not shown on the drawing

W/M Tank

Figure 5–36



Installation of W/M Tank Equipments

Figure 5–37

11.6 Lavatory, Water Supply/Drain System

11.6.1 Lavatory

The lavatory is surrounded by bulkheads made of sandwiched paper honeycomb panels and a door. The following items are installed in the compartment.

a. Chemical toilet and toilet support

b. Mirror cabinet

c. Wash stand

d. Coat hanger

e. Assist handle

11.6.2 Water Supply System

Water for lavatory uses is stored in the lavatory water tank located on the bulkhead between the lavatory compartment and the aft cargo compartment. Capacity of the tank is 20 liters approximately.

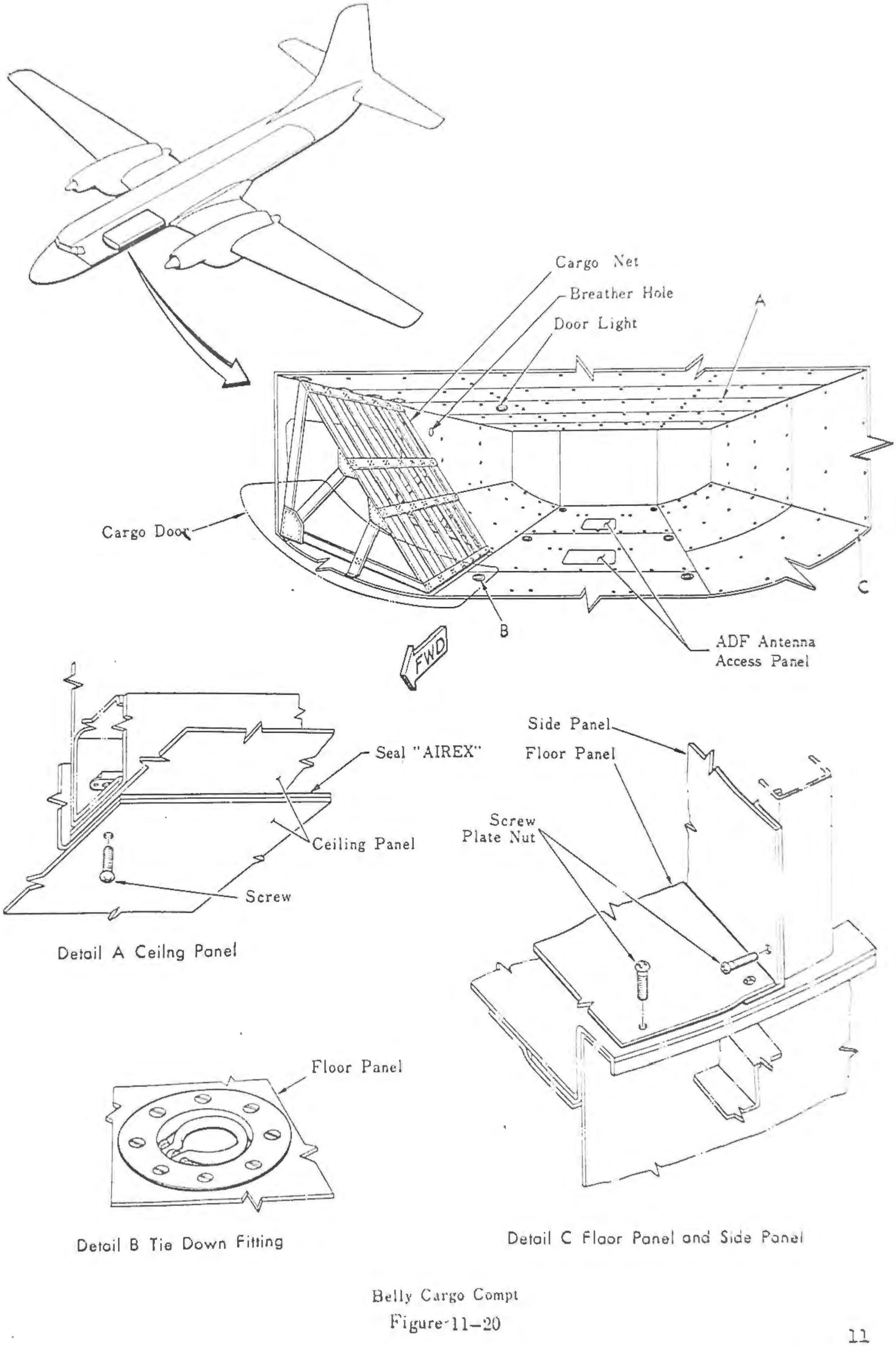
This storage tank can be filled from the water service panel which is found immediately behind the service door.

On the water service panel are provided with a supply port and an overflow port, and a check valve and a drain valve are installed in the supply line.

The drain valve must be closed except when water is being drained from the tank. Moreover, the water tank is provided with an overflow valve which lets out air and overflowing water during water re-filling.

11.6.3 Drain System

Waste water flows from the galley and the lavatory are joined together under the floor and discharged by way of the buffet drain outlet located in the rear bottom on the L.H. side of the fuselage.



Detail A Ceilng Panel

Detail B Tie Down Fitting

Detail C Floor Panel and Side Panel

Belly Cargo Compt
Figure-11-20

11.7 Cargo Compartments

In the fuselage of the aircraft are provided a forward cargo compartment, an aft cargo compartment and a belly cargo compartment which are described in details as follows:

	Volume (ft^3)	Capacity (lb.)	Tie down rings (ea.)
Forward cargo compartment	94	1,200	6
Aft cargo compartment	171	2,000	11
Belly cargo compartment	70	1,000	8

In each compartment is provided a placard showing its capacity and the strength of each floor.

As mentioned above, the compartments have 6, 11 and 8 tie down rings attached to the flooring, respectively. The flooring is coated with epoxy paint in order to prevent damages to the surfaces.

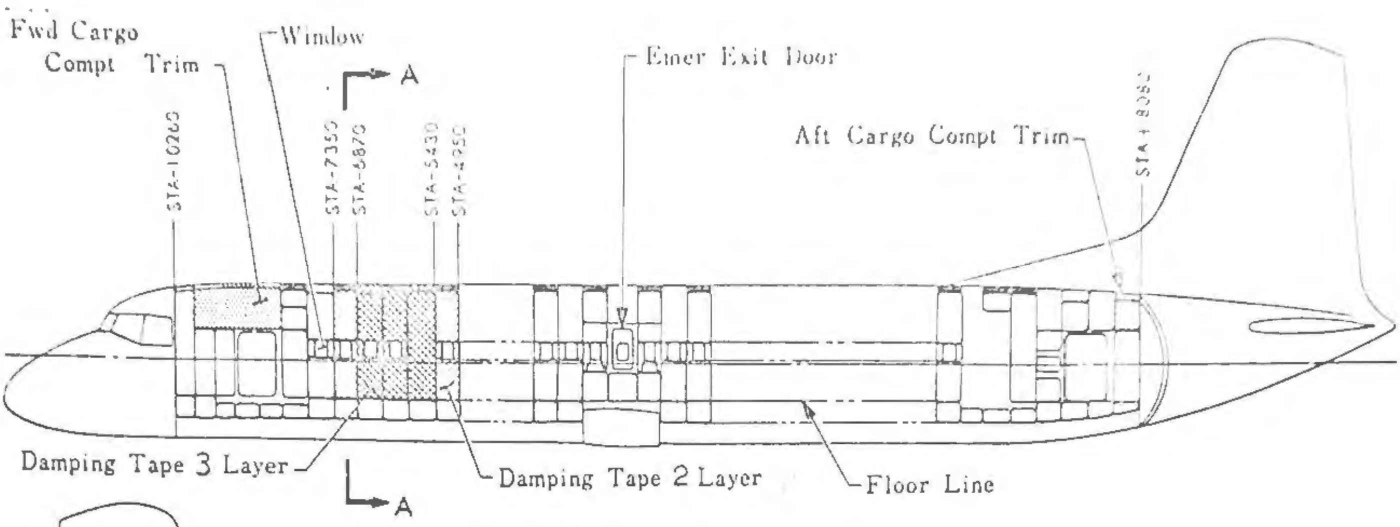
The belly cargo compartment located beneath the floor is provided with a netting so that the cargo does not lean against the door.

11.8 Heat Insulation and Sound Proofing

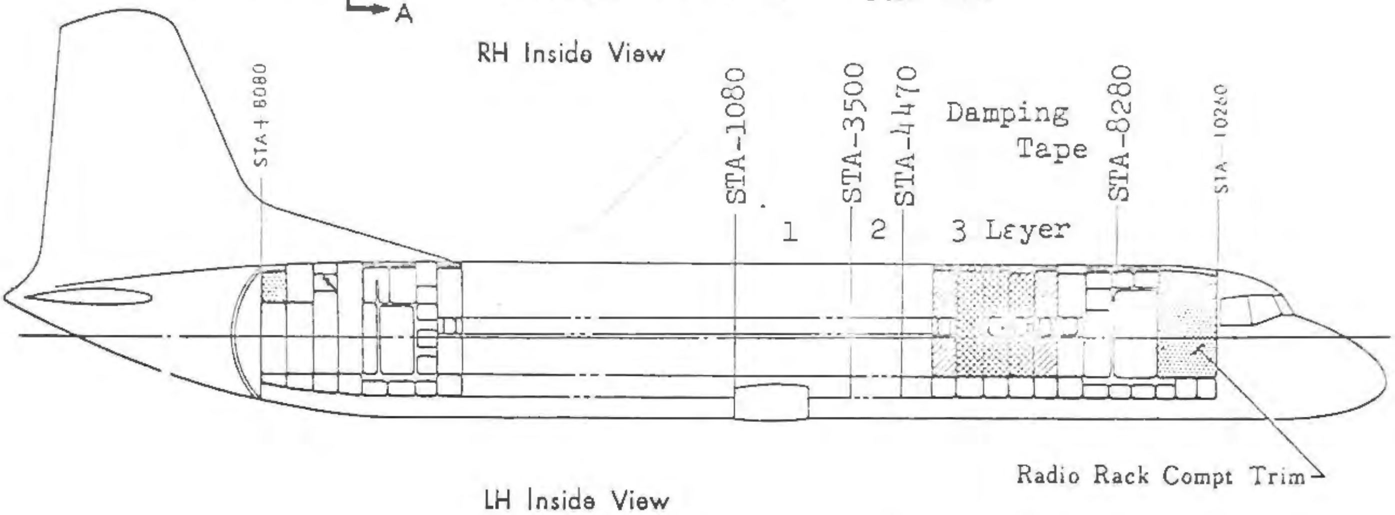
In order to achieve heat insulation and sound proofing effect in the compartments, fiberglass sheets wrapped in vinyl film are placed between the skin and the cabin trim filling spaces between the respective frames and the fiberglass sheets are fastened to the fuselage with buttons and adhesive.

Beneath the skin near the propellers, damping tape (aluminum foil) is provided in three layers in addition to the said fiberglass sheeting. 1/8 in thick rubber sheet is also located inside the ice plate. Around the cabin entrance where the stairway is mounted damping tape in three layers is spread on the inner face of the skin in place of the fiber-glass sheeting.

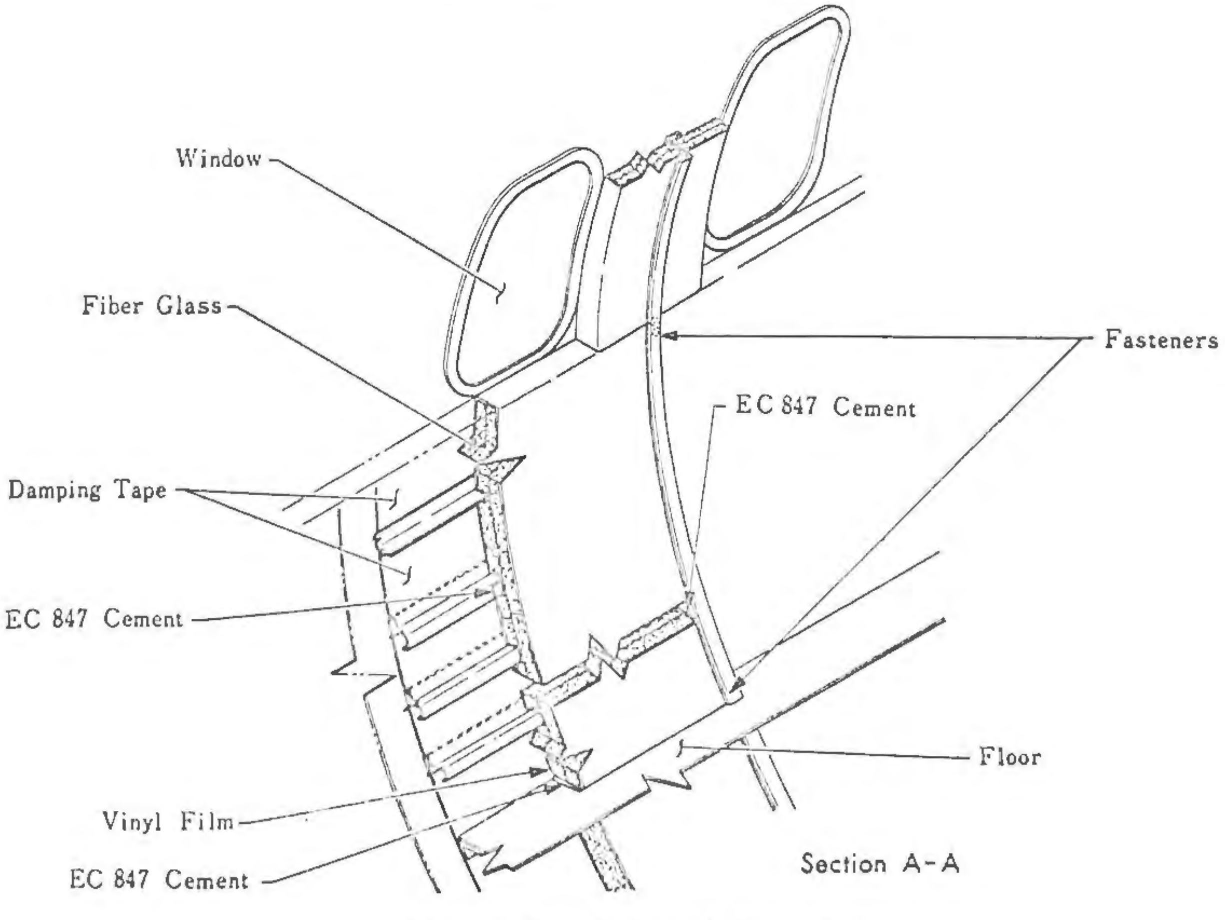
A lining material composed of nylon cloth lined with fiberglass sheeting is provided on the walls of the forward cargo compartment, the aft cargo compartment, and the radio rack compartment.



RH Inside View

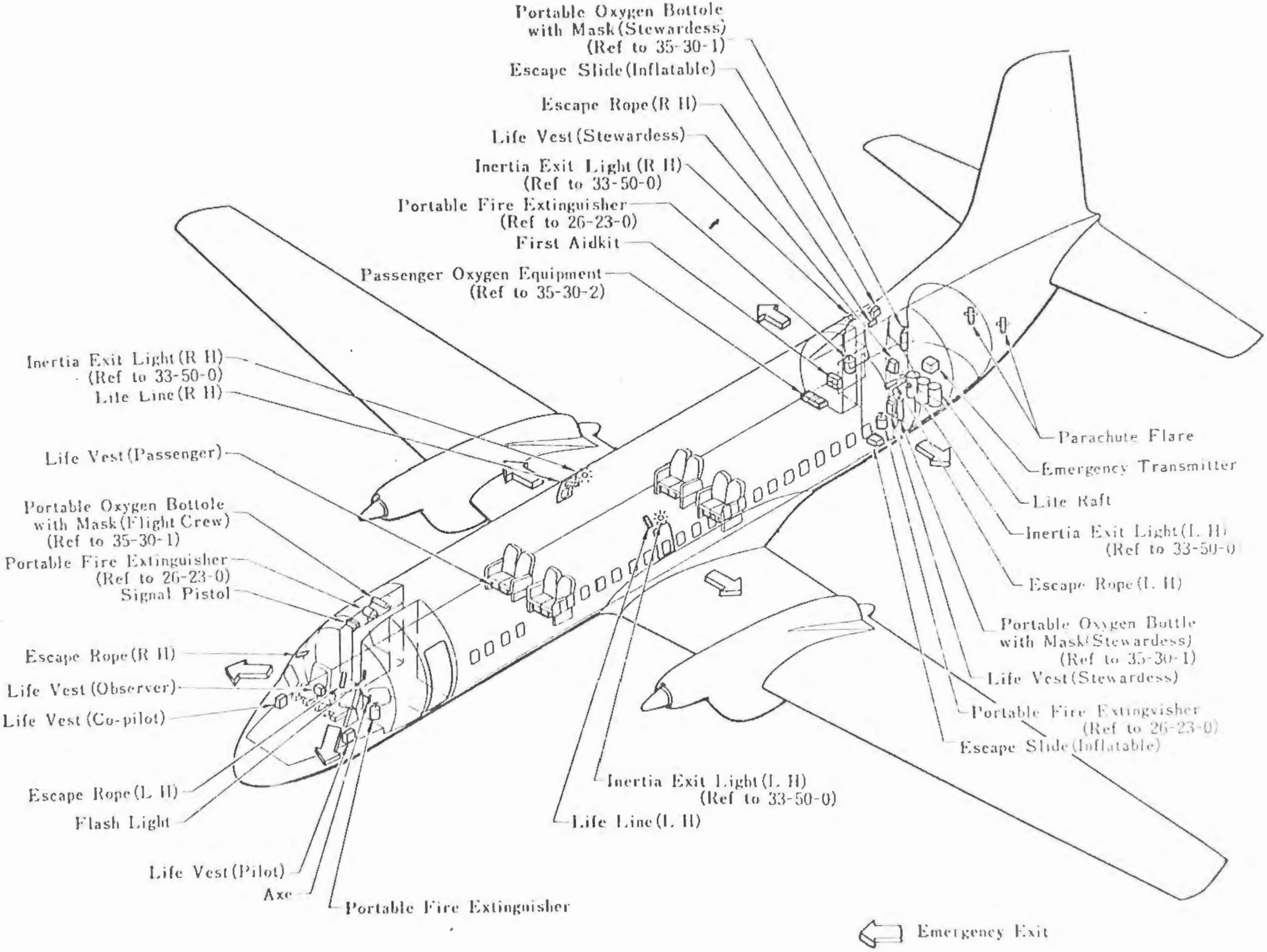


LH Inside View



Section A-A

Insulation & Sound Proofing
Figure 11-21



Emergency Equipment
Figure 11-22

11.9 Emergency and Safety Devices

Emergency and safety devices are kept at places from which they may be taken out promptly in case of emergency, and near such places are provided placards that indicate instructions that must be observed in handling the emergency and safety devices.

11.9.1 Emergency Exits

Emergency exits must be maintained in such a way that they may be employed as such in case of emergency.

(1) Sliding windshields (in the cockpit)

(2) Emergency escapes (at the center section of the fuselage on the L.H. and R.H. sides)

(3) Service door (in the aft fuselage on the L.H. side)

(4) Rear cargo door (in the rear section of the fuselage on the R.H. side)

11.9.2 Names of the Emergency and Safety Devices

As the emergency and safety devices the following items are included:

(1) ~~Signal pi~~stol

(2) Axe

(3) First aid kits

(4) Flash lights

(5) Inertia flash lights

(6) Escape ropes

(7) Life lines

(8) Escape slides

(9) ~~Life rafts~~

(10) Emergency ~~transmitter~~

(11) Life vests

(12) Portable fire extinguishers

(13) Portable oxygen bottles

11.9.3 Summary of the Emergency and Safety Devices

(1) Signal Pistol .... Made by the Koa Kako Co. (model K1)

The signal pistol is retained on a shelf in the forward cargo compartment and provided together with the pistol are smoke bombs (dark orange smoke), flare bombs, and flash bombs which are placed in containers (three bombs of each different type to a container).

(2) Axe .... Made by Air Associate No. 6701

One axe is attached to the wall on the L.H. side behind the pilot seat.

(3) First Aid Kit .... Made by Daiichi Ika Co.

One first aid kit containing eleven items is placed on the partition of the galley on the R.H. side.

(4) Flash Light .... Made by the Suiriku Denki, Model Kanamaru No. 802.

One flash light (water proof) is hung on the wall on the L.H. side behind the pilot seat.

(5) Inertia Flash Lights

Inertia flash lights are provided 1 ea. above the emergency exits. Those inertia flash lights come on automatically by means of the built in dry cells if G acts on them. It is therefore necessary to place the switches of the flash lights in "Auto". They are also provided with "manual" switching devices for the convenience of checking the dry cell lamps.

(6) Escape Ropes

Escape ropes for emergency escape placed in containers are located beside the sliding windshields, the aft cargo door, and over the service door or in a container provided on the wall by the service door.

One end of each rope is fixed to its container. The ropes are long enough to reach the ground from the exits. The rope for the aft cargo door is used by placing its hook on the fitting provided on the emergency exit.

(7) Life Line

This life line is placed on the hat rack above the emergency exit in the center section of the fuselage, and is used to guide the passengers from the fuselage to the wing in case of ditching. One end of the line is fixed to the fitting installed above the emergency exit and the other end to the fitting on the engine frame in the nacelle.

(8) Escape Slides

Two escape slides are provided, one on the service door and the other on the aft cargo compartment door. Each escape slide has a high pressure air bomb (3,000 psi) and it can be inflated rapidly with the bomb after the slide has been thrown outside the fuselage and fastened to the fitting found at the emergency exit.

(9) Life Rafts

Three rafts which are wrapped in vynilon cloth individually are placed in the aft cargo compartment. One life raft is usually capable of seating 25 persons in general, consisting of the upper and lower air chambers. The life raft may be inflated with the CO_2 automatic inflator contained in the raft. The following items are contained in a bag:

a. Tent and its struts

b. Oars

c. Bellows and hoses

d. Repair tools

e. Bailer and sponge

f. Set of emergency and safety devices

g. Water bag

h. Flash light

i. Whistle

j. Compass

k. Seawater distiller

l. Spare ropes

m. Heliograph

n. Smoke signal

o. Jack knife

p. Water proof matches

q. Pliers

r. Dye marker

s. Fishing tackles

t. Seawater desalting device

u. Work gloves

v. Shark protector

w. Instruction manuals

(10) Emergency Transmitter

An emergency transmitter is placed in the aft cargo compartment and is used to transmit distress signals, in case of ditching, on electric power supplied from a hand operated generator. This emergency transmitter is capable of transmitting SOS signals automatically at transmitting frequencies of:

500 kc, 1,000 cps, modulated output 2.5 watts
8,280 kc, non-modulated output 2 watts.

The emergency transmitter is provided with the following accessories:

a. Kite (used for hoisting the antenna)

b. Balloon (used for hoisting the antenna when there is no wind)

c. Hydrogen producer (used to inflate the balloon)

d. Signal lamp (put on the head of the transmitter operator)

e. Antenna assembly (used for radio transmission)

f. Parachute (used for dropping)

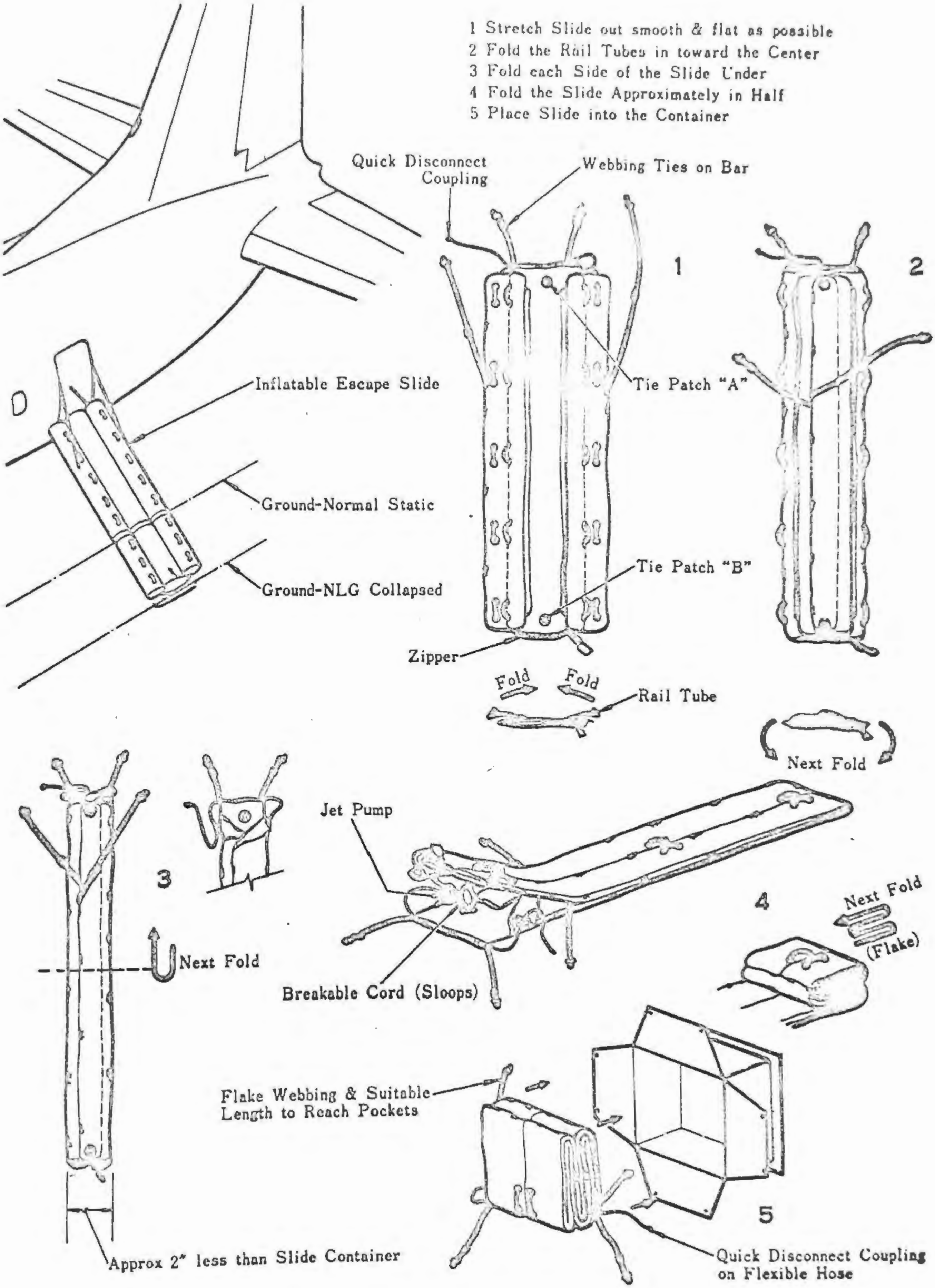
(11) Life Vests

Cushion of the seat is available for survival devices.

(12) Portable Fire Extinguishers

A total of four portable fire extinguishers are provided 1 ea. in the rear and on the L.H. side of the cockpit, in the forward cargo compartment, beside the service door, and near the aft cargo compartment door.

(13) Portable Oxygen Bottles



1 Stretch Slide out smooth & flat as possible
2 Fold the Rail Tubes in toward the Center
3 Fold each Side of the Slide Under
4 Fold the Slide Approximately in Half
5 Place Slide into the Container

Escape Slide Maintenance Practice

Figure 11–23

Chapter 12 AIR CONDITIONING SYSTEM

12.1 General Description

12.1.1 General

This system accomplishes the following functions for the space between the cockpit forward pressure bulkhead (Sta-12310) and the aft pressure bulkhead (Sta-6000).

PRESSURIZATION: The system is capable of pressurizing the aircraft up to a maximum differential pressure of 4.16 psi with respect to the atmospheric pressure. This corresponds to the atmospheric pressure altitude of the pressurized compartment at 8,000 ft when the aircraft is at an altitude of 20,000 ft.

VENTILATION: The air in the portion above the floor in the aforesaid range is changed at a rate of once in two or three minutes.

TEMPERATURE CONTROL: Cabin and cockpit temperatures can be controlled independently.

PRESSURE RELIEF: If the differential pressure between the air pressure in the pressurized compartment and the atmospheric pressure exceeds 4.41 psi, the safety valve is actuated, relieving the air pressure in the pressurized compartment and protecting the airframe. On the other hand, if the atmospheric pressure becomes 0.2 psi or more higher than the pressure in the pressurized compartment, the external air is let in the pressurized compartment through the functions of the safety valve to eliminate the pressure difference.

In addition, a ram air valve is provided for the ventilation and pressure reduction of the pressurized compartment by introducing the external air into it in the event of an emergency or on other occasions.

In order to supply air for pressurization and temperature control, the system is provided with cabin superchargers which are driven by the right and left engines through the gear boxes.

12.1.2 Construction

The air conditioning system, which consists of various components working in coordination, may be divided into the following sub-systems.

(1) Compression and spill

(2) Cooling

(3) Pressure control

(4) Temperature control

12.1.3 Features

(1) To supply air, two roots type compressors are located in the gear boxes of the right and left nacelles and are driven by the engines.

(2) As the compression rate of the roots type compressor is small and the temperature of discharged air is high, a boot strap type consisting of a cooling turbine provided with two heat exchanges and one compressor is employed, offering improved cooling effects.

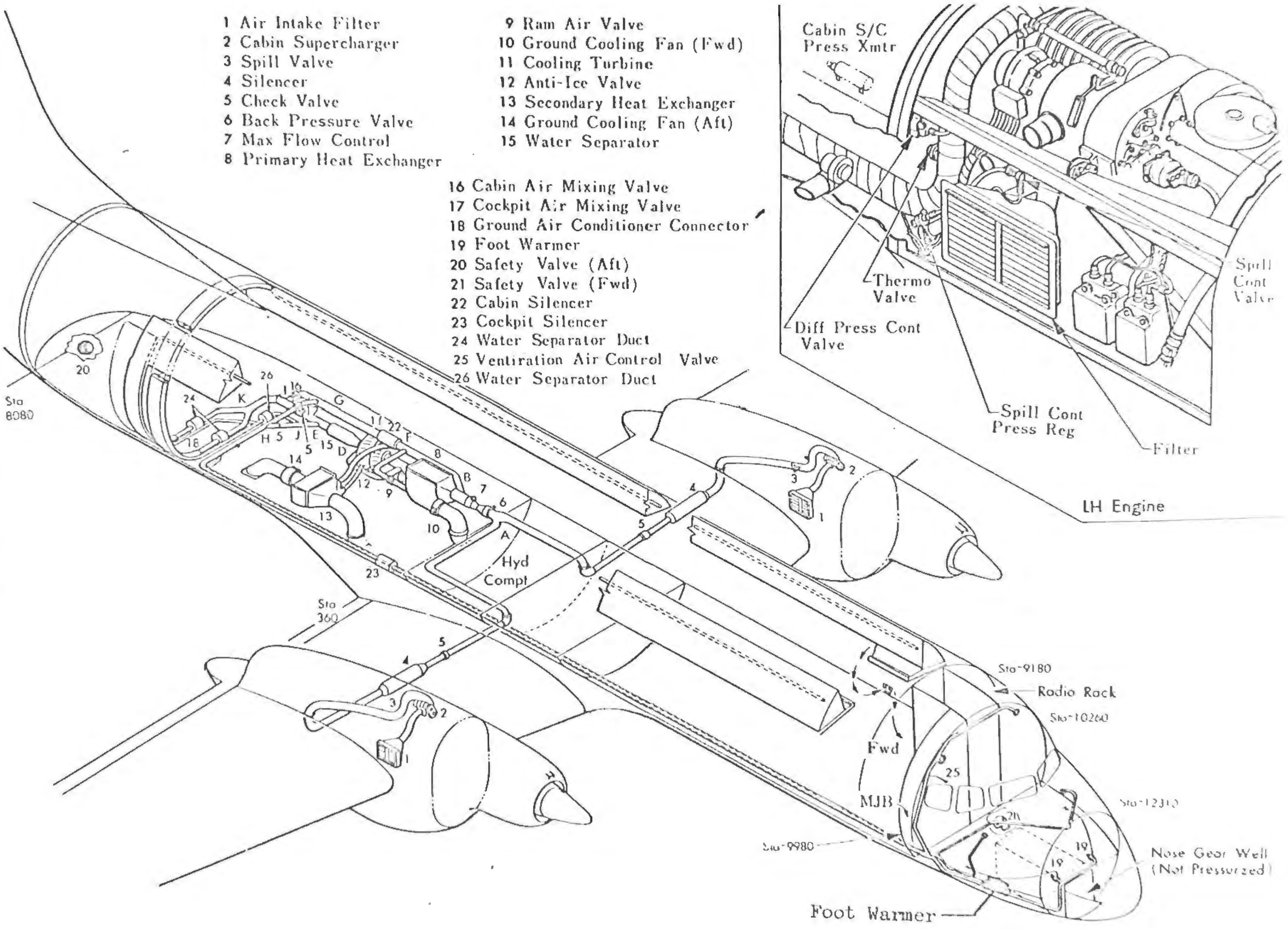
(3) Even when the aircraft is on the ground, sufficient cooling can be done by driving the cooling fan, if the engines are running.

(4) The pressurization system is operated fully pneumatically, using no electrical power.

(5) No space heater is provided. Space heating is accomplished by applying back pressure to the roots type compressors.

(6) Even when one engine is inoperative, sufficient pressurization can be maintained during flight.

(7) Air discharged from the compressors can be by-passed into the atmosphere by spill valves located on the outlet sides of both the right and left compressors.



Air Conditioning System Arrangement
Figure 12-1

12.2 Compression and Spill System

12.2.1 System Operation

Both the right and left systems take in atmospheric air from the air intake located on the right side of the respective engine nacelles, and send it to the superchargers where it is compressed (max. 12.5 ±0.25 psi or less) and is sent through the silencer and check valve located in the trailing edge of the respective wings. Air from the right system and air from the left system meet with each other in the rear part of the center wing under the floor of the cabin.

The joined air flow is divided again into a system which produces hot air for pressurization, heating and ventilation and a system which produces air flow for cooling.

The compression system has the following safety systems: In other words, provision is made to limit the pressure, temperature and flow rate for the protection of the supercharger and the cooling turbine. Furthermore, a spill control system, which by-passes the compressed air outboard, is provided for the protection of the engines from overload.

The maximum flow control, which limits the flow rate, controls the left side only.

12.2.2 Major Components

(1) Compression System Components

Part Name	Location	EA/SHIP
Air intake	Nacelle RH	2
Supercharger	Nacelle Gear Box	2
Silencer	Inner Wing T. Edge	2
Check Valve	Inner Wing T. Edge	2

(2) Spill System Components

Part Name	Location	EA/SHIP
Spill Valve	Eng. Nacelle RH	2
Press Regulator	Eng. Nacelle RH	2
ΔP Control	Eng. Nacelle RH	2
Thermo Valve	Eng. Nacelle RH	2
Max. Flow Control	FWD Air Cond. Compt.	1
Solenoid Valve	Eng. Nacelle RH	2
Thermo S.W. (163°C)	AFT. Air Cond. Compt.	1
Thermo S.W. (110°C)	Cooling Turbine	1

12.2.3 Compression System

(1) Air Intake Filter Box

The air intake filter box is located on the starboard of the engine and consists of a screen, filter (felt folded in pleats) and a relief valve.

The relief valve, located at the bottom, is opened at the supercharger intake pressure of 20±2 in. sq. when the filter is blocked with icing etc.

(2) Supercharger

a. Functions

(a) Type and component No.

	LH	RH
Type No.	15, MK14, S2B	15, MK14, S2D
Part No.	139187	139202

The difference of type no., results from the shape of removable outlet manifold attached on the supercharger. Each supercharger itself is identical so that its interchangeability is available.

(b) Compression

Roots type with a compression ratio of 2.

(c) Delivery capacity

800 to 860 ft^3/min at an aircraft altitude of 20,000 ft.

(d) RPM

It is obtained by multiplying the engine speed by 0.8, its maximum speed being 12,000 rpm.

b. Operation

If the pressure ratio of the roots type supercharger is maintained constant, its driving horsepower becomes almost proportional to the rpm.

Since its rate of delivery is almost constant at a constant rpm, the roots type supercharger is ideally suited for planes such as transports which fly at a constant speed while maintaining the same differential pressure.

In order to change air flow while keeping rpm constant, however, it is necessary to discharge surplus air or to throttle the suction on the inlet side of the supercharger. Furthermore, a safety device is needed against a rise in the delivery pressure caused by the surplus air. This device is the spill control system described later which is a by-pass system located on the outlet side of the supercharger.

The pressure ratio of the roots type is lower than that of the centrifugal type, and its efficiency generally lower, but the roots type is free from compressor stall and other phenomena which are seen in the centrifugal type.

Furthermore, the temperature of outlet air flow can be increased by applying proper back pressure to the outlet side so that it can be used as a space heating source.

This type of supercharger develops noise which increases with rpm so that a silencer is needed in the downstream. Since the YS-11 is a twin-engine aircraft, a check valve is provided to prevent back flow from the operative supercharger to the outlet side of the inoperative supercharger when one of the engines is inoperative.

Lubrication is accomplished through an oil route in which engine oil circulates from the gear box to the supercharger and then back to the gear box again so that the supercharger does not require special oil servicing.

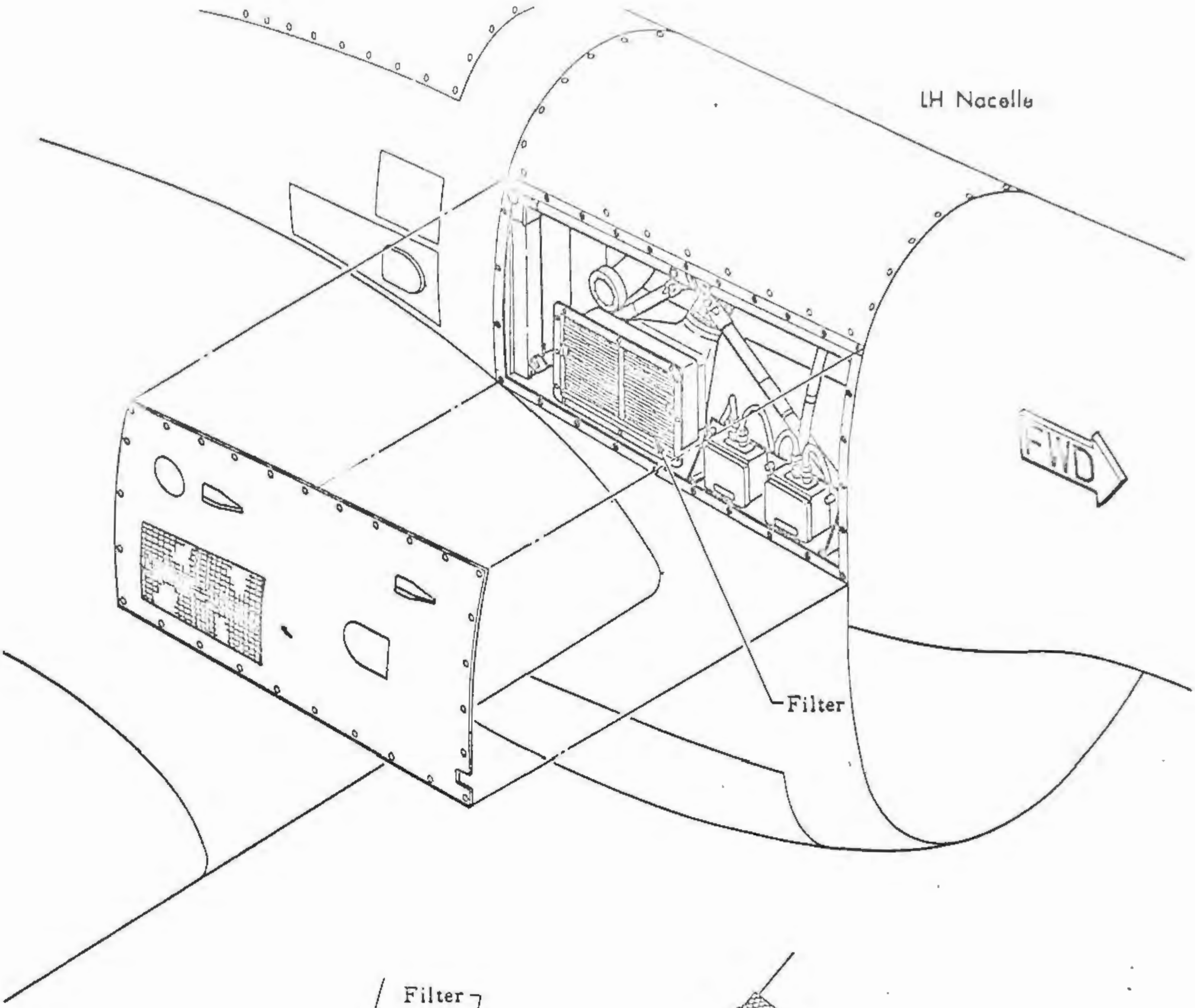
(3) Silencer

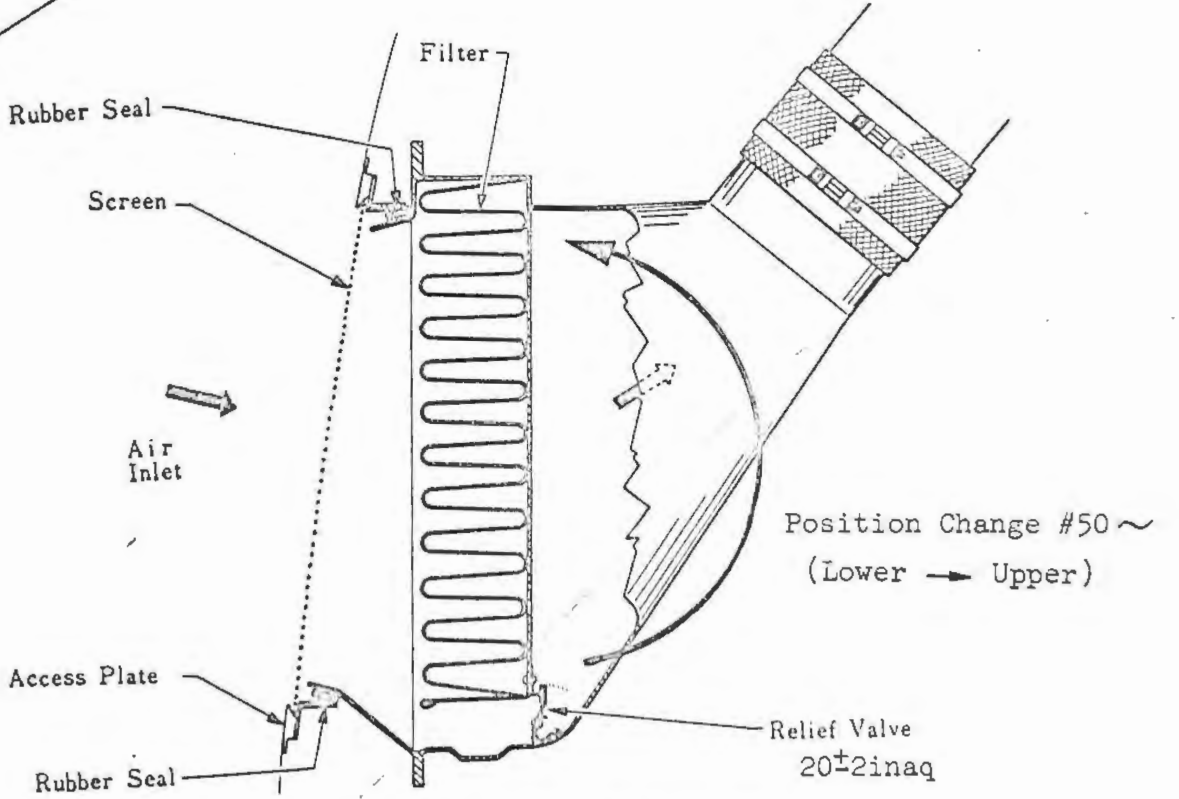
Type V9975

This is a Helmholz resonator. One each is provided on the port and starboard.

(4) Check Valve

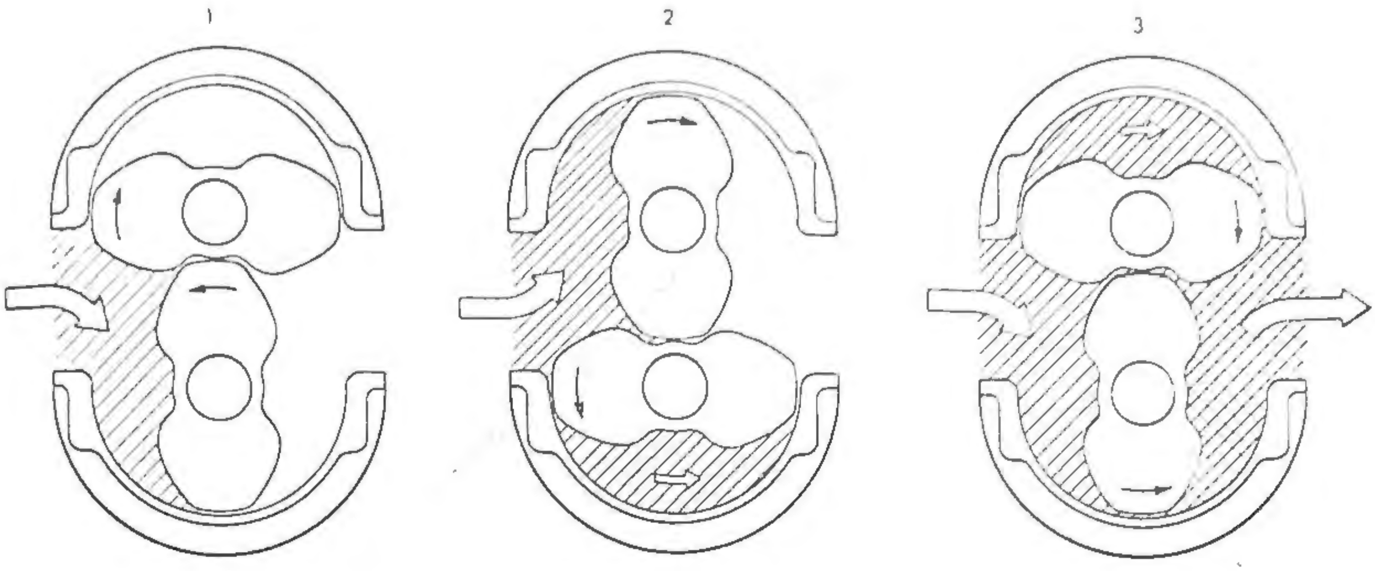
The maximum working air pressure is 15 psi ($70^\circ {}^{+30^\circ F}_{-10^\circ}$). The back flow air volume needed to prevent back flow is 6 lb/min max.



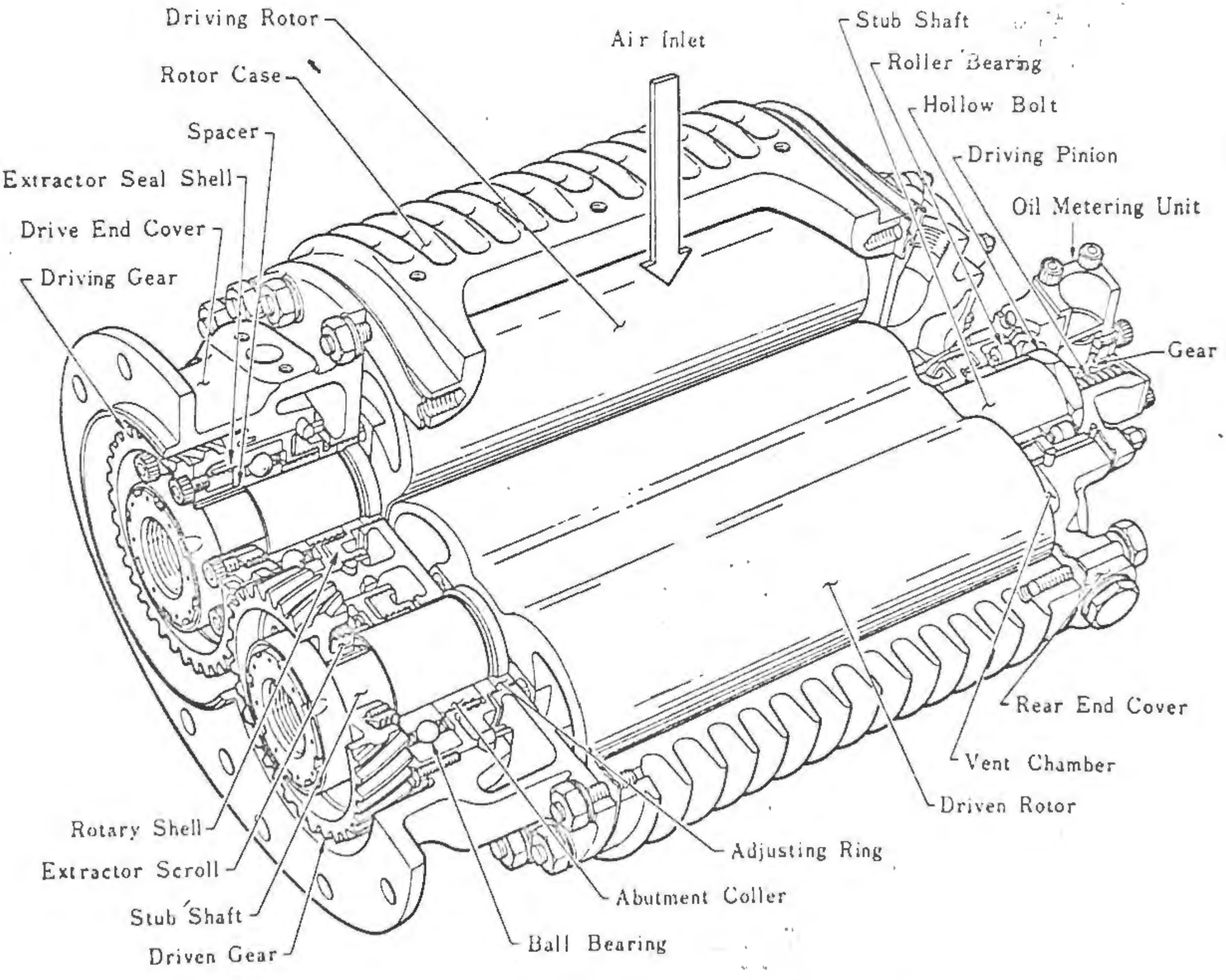


Cabin Air Filter Box

Figure 12-2



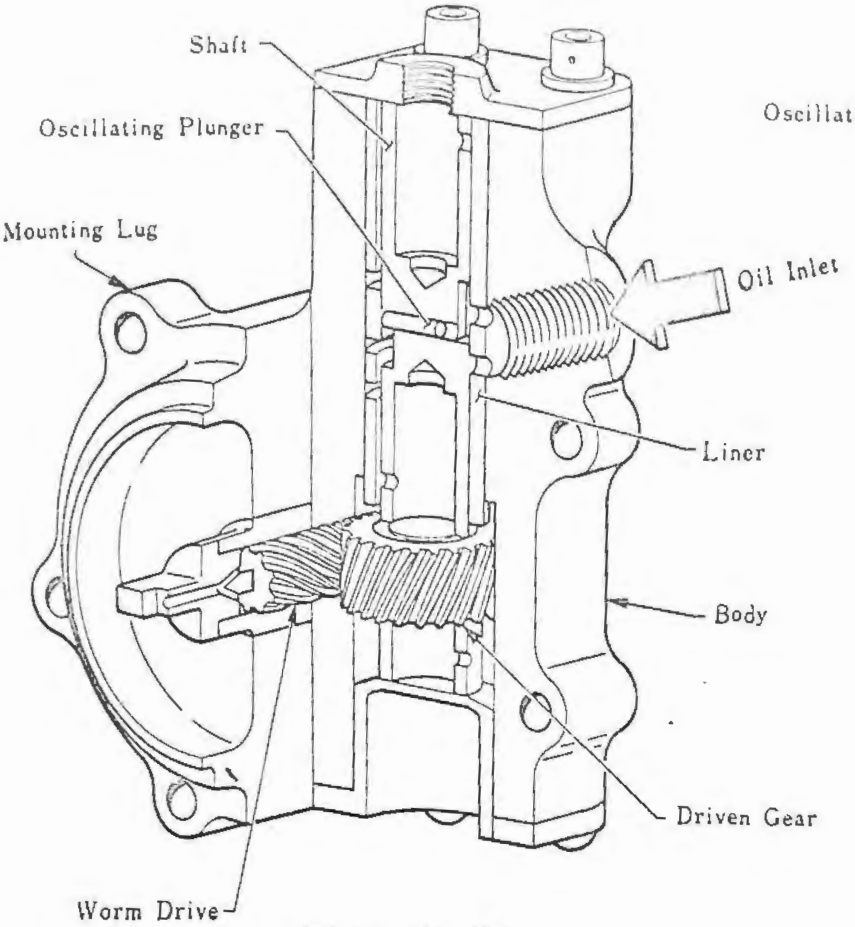
Principle of Operation

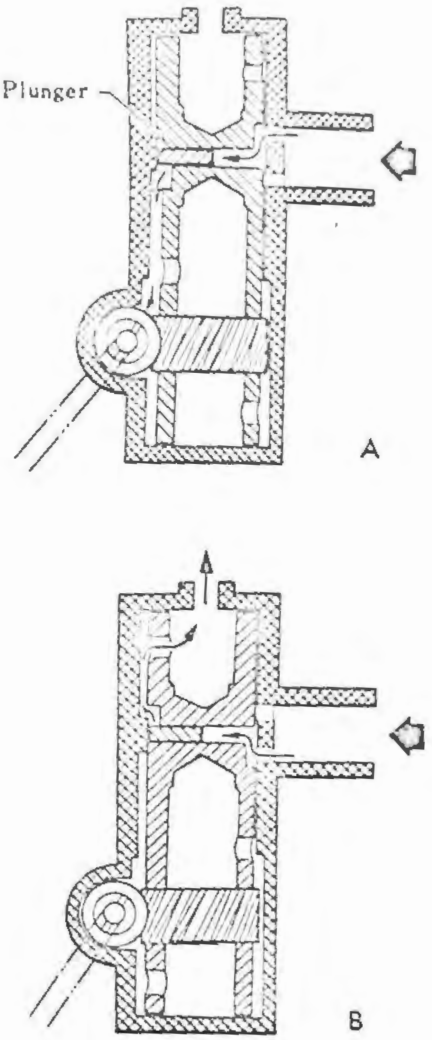


Cutway View of Supercharger

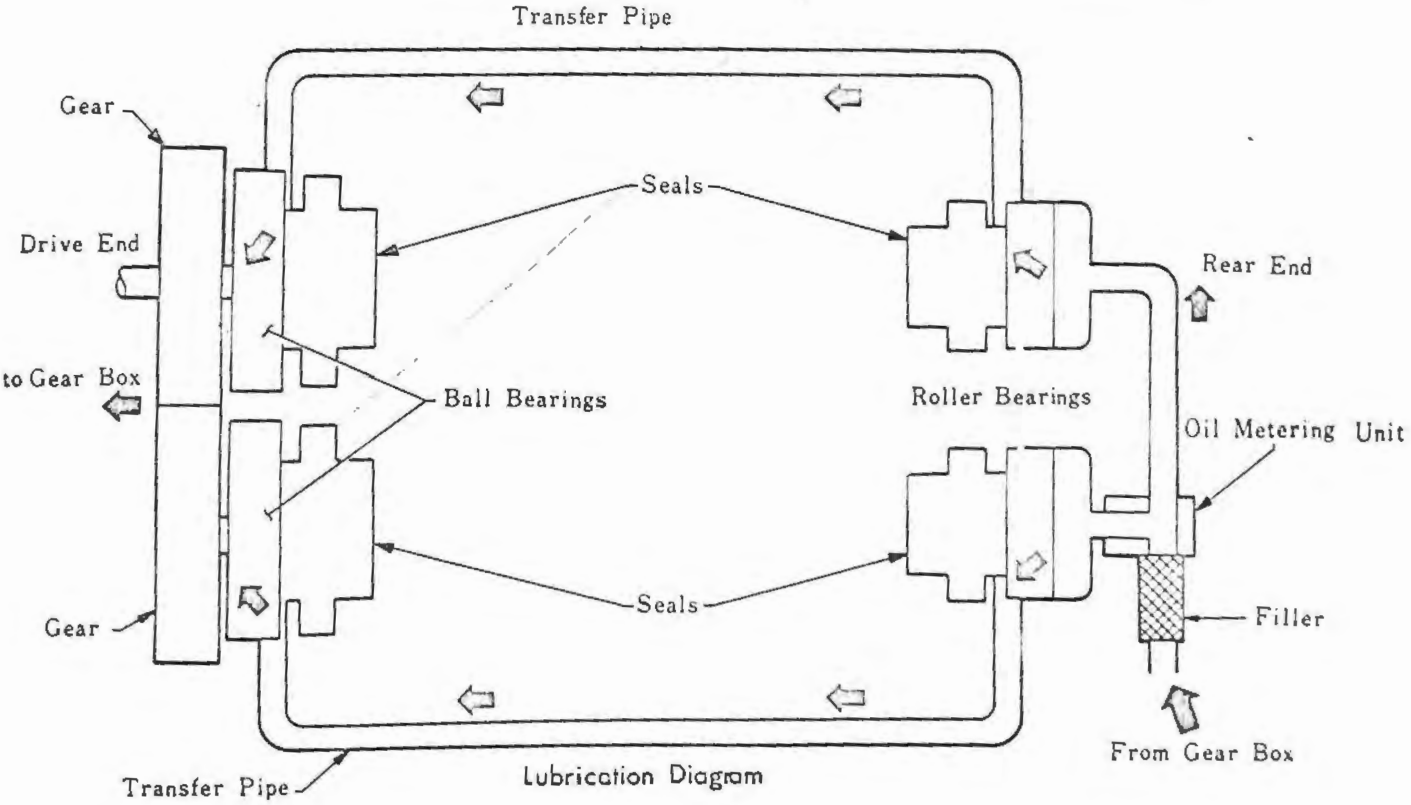
Cabin Supercharger

Figure 12-3.



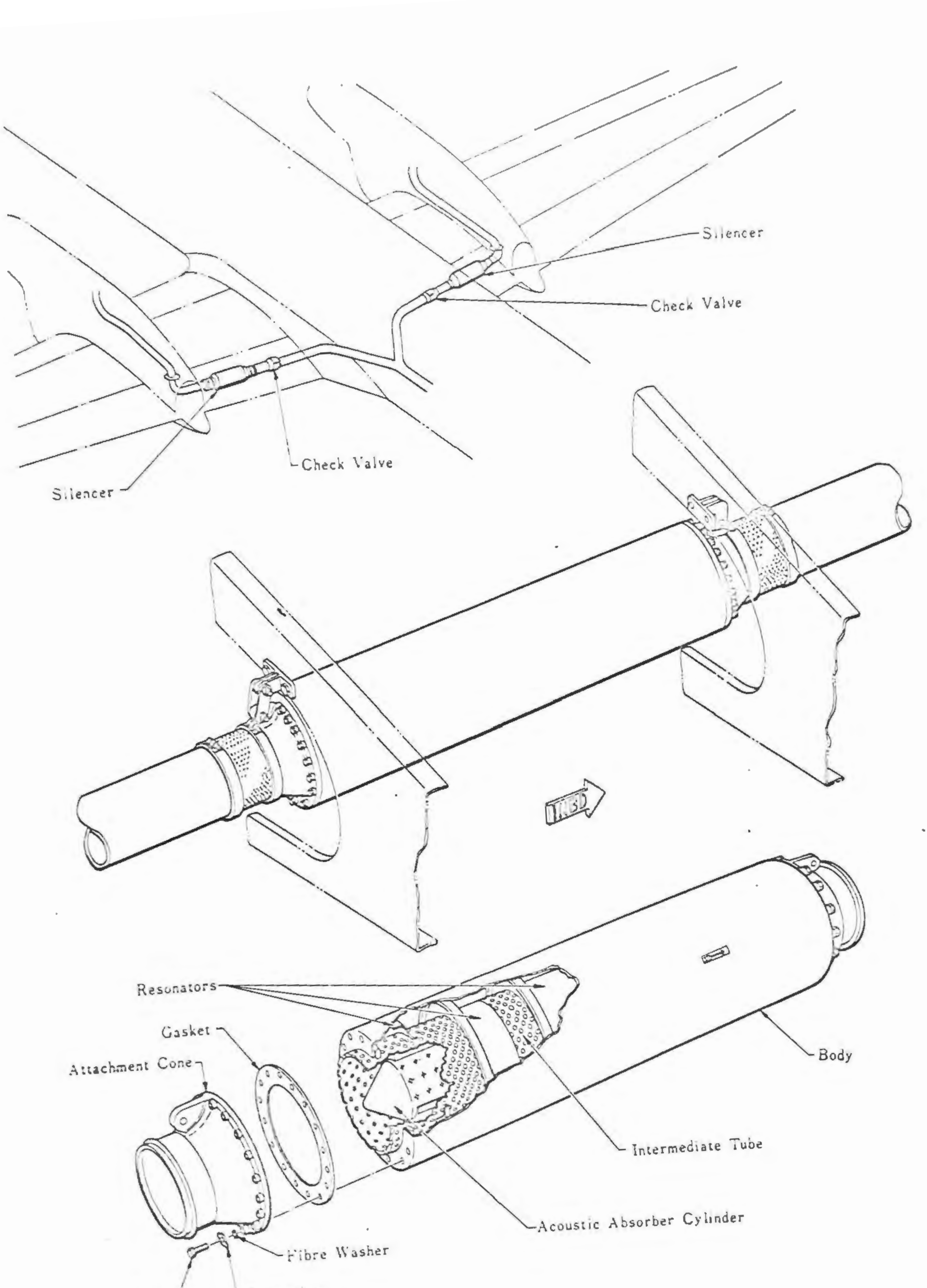


Oil Metering Unit



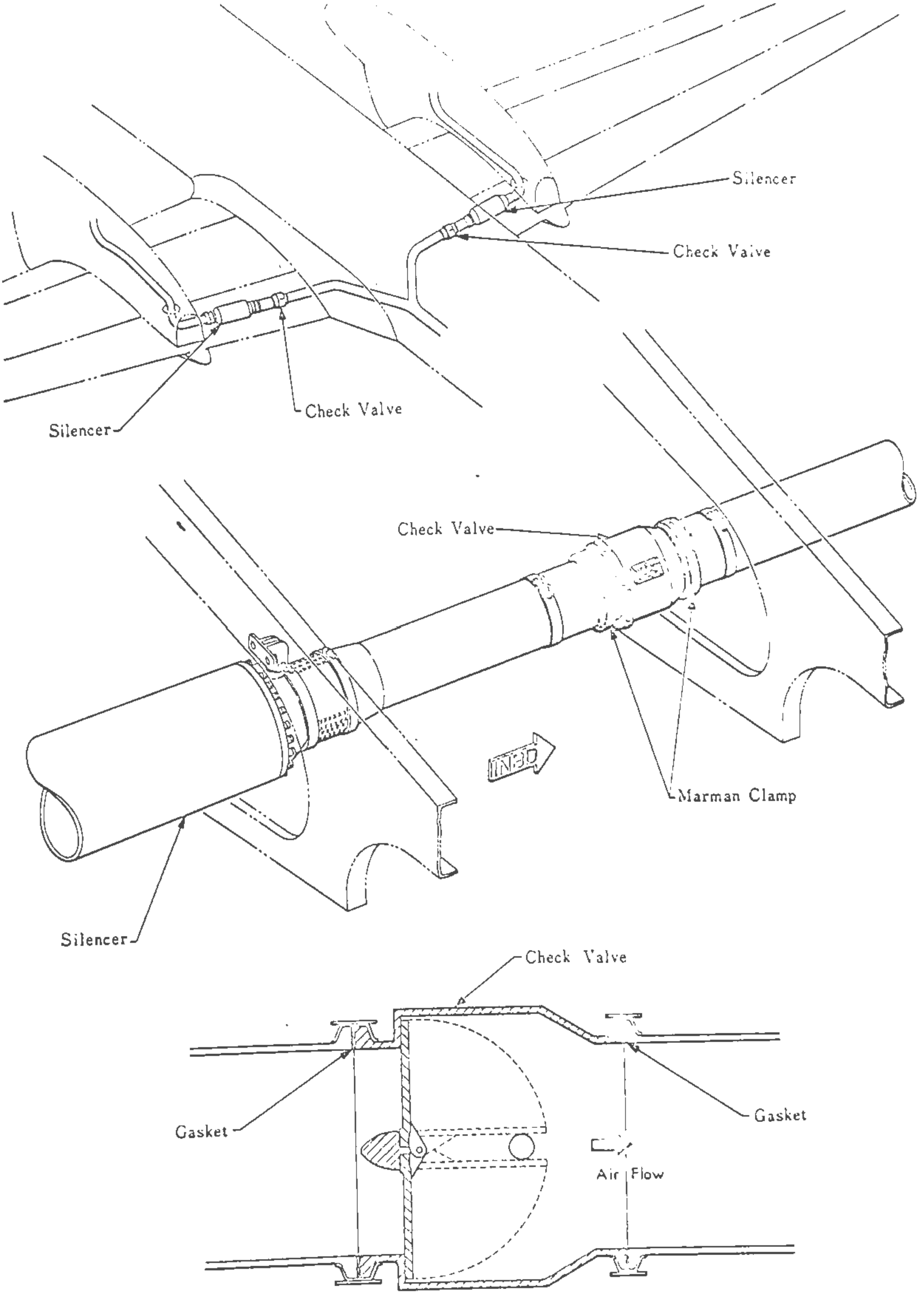
Lubrication Diagram

Cabin Supercharger Lubrication
Figure 12–4



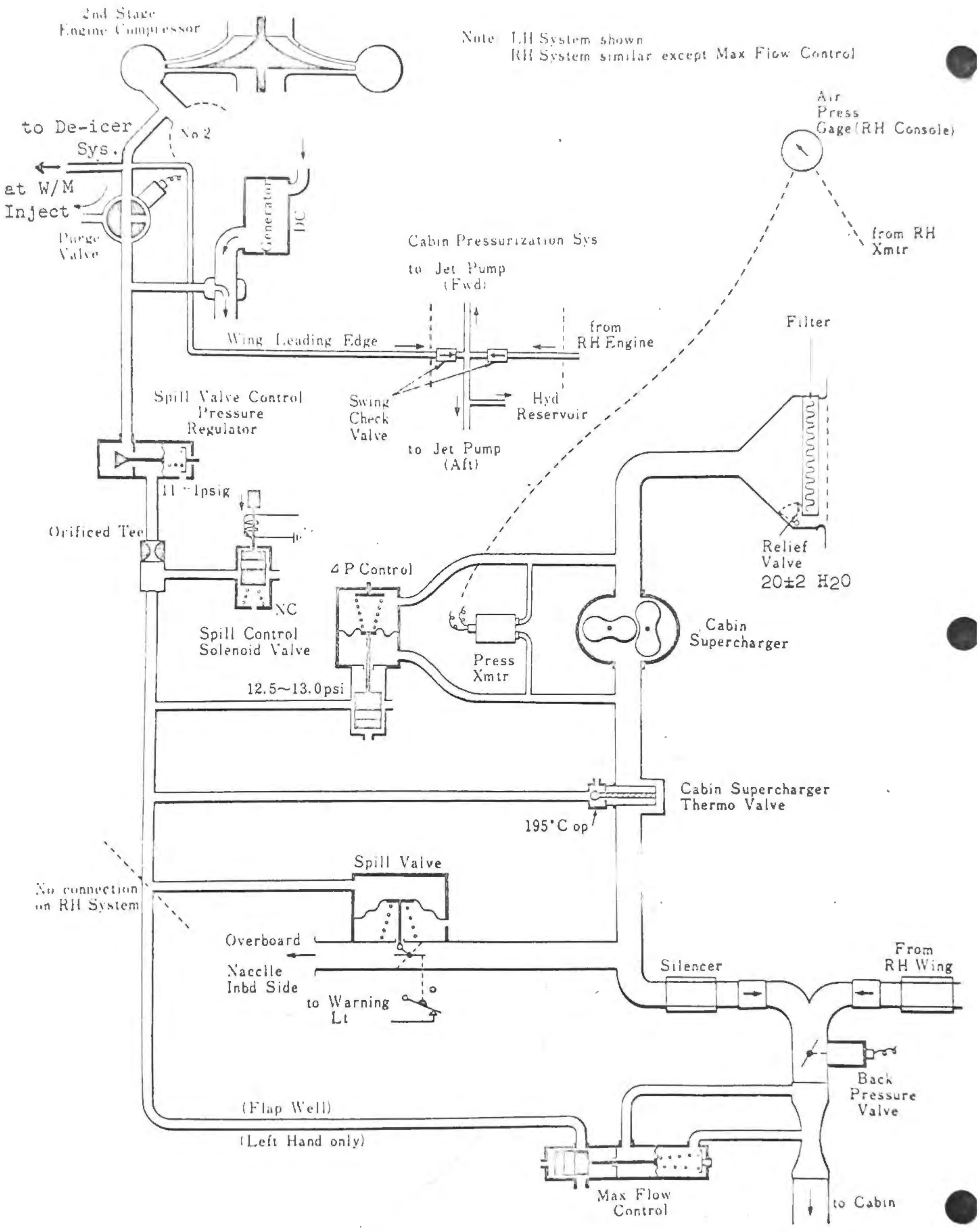
Silencer

Figure 12–5



Cabin Supercharger Check Valve

Figure 12-6


Note: LH System shown
RH System similar except Max Flow Control

Spill Control System

Figure 12-7

High pressure acting on the interior of the respective diaphragms through the adjustable orifice is intended to abate the pulsating pressure from the supercharger outlet.

For ΔP control, an inlet valve with spill servo pressure at 11.0±0.1 psi and an outlet port to its ambient are also provided. If the differential pressure between the high and low pressure sides reaches 12.5±0.25 psi or more, the inlet and outlet ports are connected by the function of the metering valve directly coupled with the diaphragm assembly, thus venting the pressure of the servo pressure line and increasing ΔP through the spill valve.

(5) Supercharger Thermo Valve

The thermo valve consists of a temperature sensing element, which is composed of a high rate-of-expansion housing containing a low rate-of-expansion core, and a spring-loaded ball type valve mechanism connected to one end of the sensing element.

To one end of this valve, 11.0±0.1 psi of the spill servo pressure line is applied through the supply port. The other end is an ambient vent open to the atmosphere.

If the temperature at the outlet of the supercharger rises, the adapter mounted on the core is pulled because of the difference in the rate of expansion between the core and housing (core expansion   housing expansion) so that the ball type valve is opened, establishing the passage from the supply port to the ambient vent for the relief of the servo pressure line pressure 11.0±0.1 psi.

As a result, the spill valve is opened. The temperature setting is 195°C.

(6) Spill Control Solenoid Valve

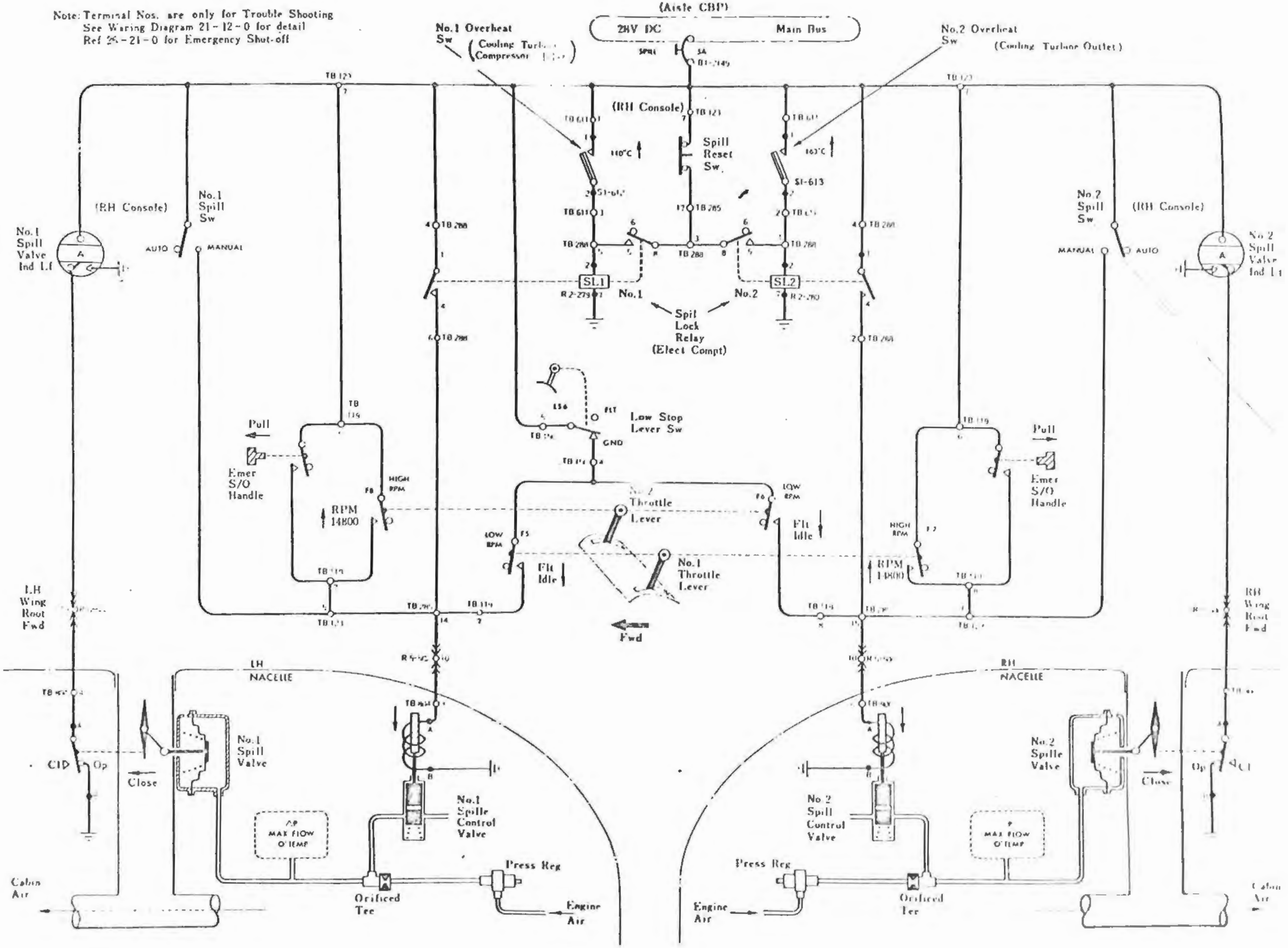
The valve is located on the fuselage side of each of the right and left nacelles. Their mounted positions are slightly different from each other.

The valves are opened electrically and let the servo pressure of 11.0±0.1 psi escape.

(7) Maximum Flow Control

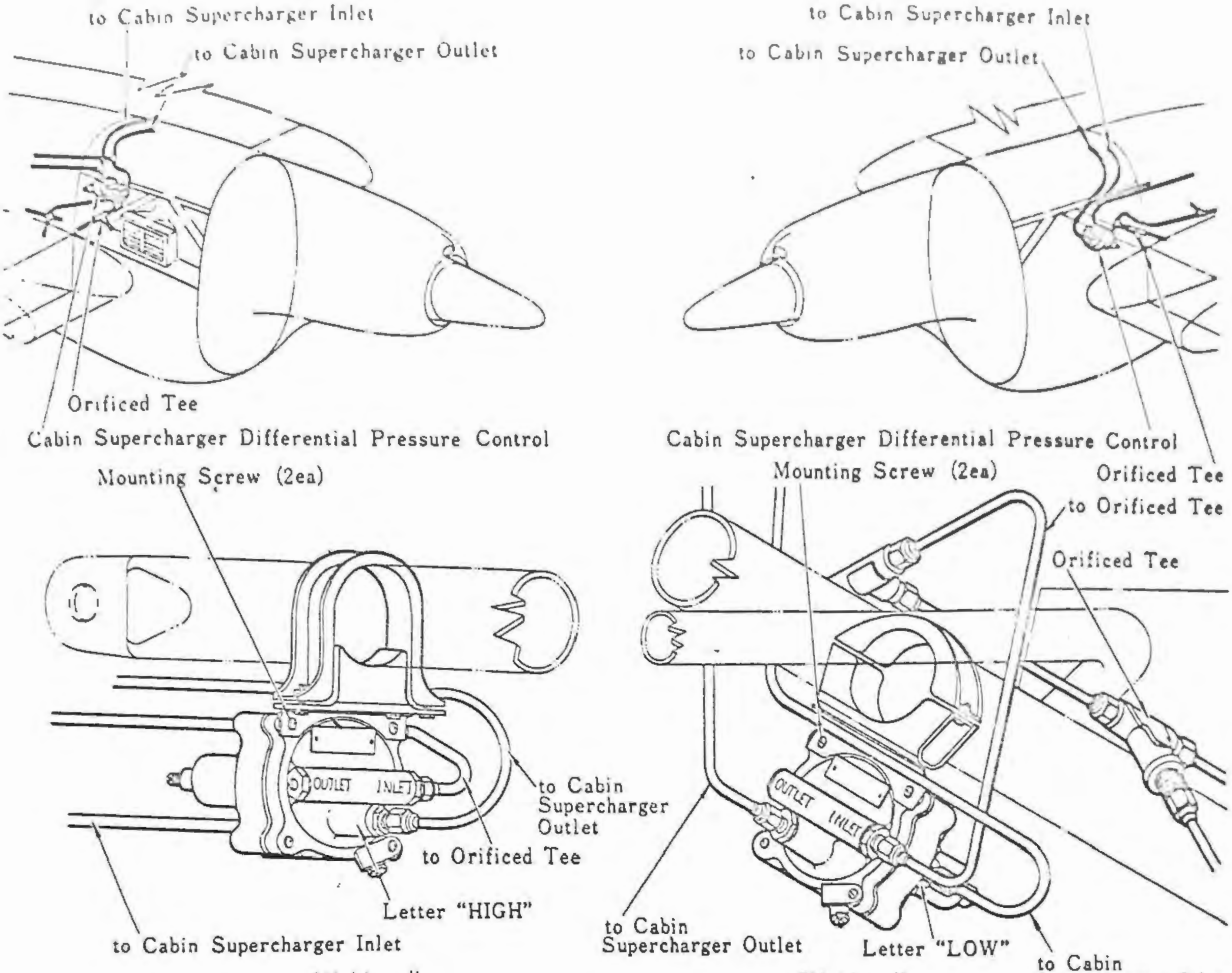
This consists of a venturi body assembly and a flow control servo valve.

From the inlet pressure sensing port and the throat pressure sensing port of the venturi body, the respective pressures are led to both sides of the diaphragm of the flow control servo valve. If the air flow reaches $75.2\sqrt{\rho}$ ±10% lb/min (ρ: air density), the inlet pressure sensing side overcomes the throat pressure sensing side and pushes the diaphragm.
As a result, the servo metering valve is actuated, relieving the spill control servo pressure through the vent, and opening the spill valve.



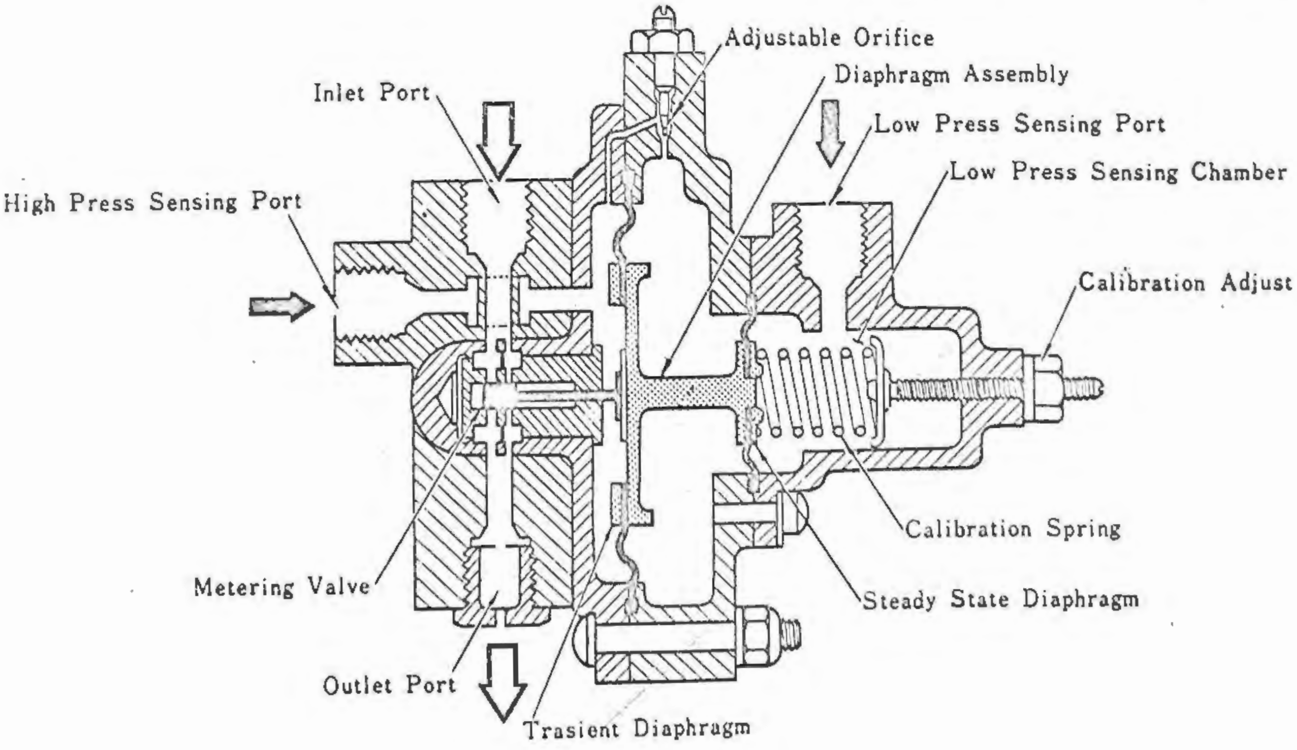
Spill Control Electric System Schematic

Figure 12-8


to Cabin Supercharger Inlet
to Cabin Supercharger Outlet
Orificed Tee
Cabin Supercharger Differential Pressure Control
Mounting Screw (2ea)
OUTLET
INLET
to Cabin Supercharger Outlet
to Orificed Tee
Letter "HIGH"
to Cabin Supercharger Inlet
to Cabin Supercharger Inlet
to Cabin Supercharger Outlet
Cabin Supercharger Differential Pressure Control
Orificed Tee
Mounting Screw (2ea)
to Orificed Tee
Orificed Tee
OUTLET
INLET
to Cabin Supercharger Outlet
Letter "LOW"
to Cabin Supercharger Inlet

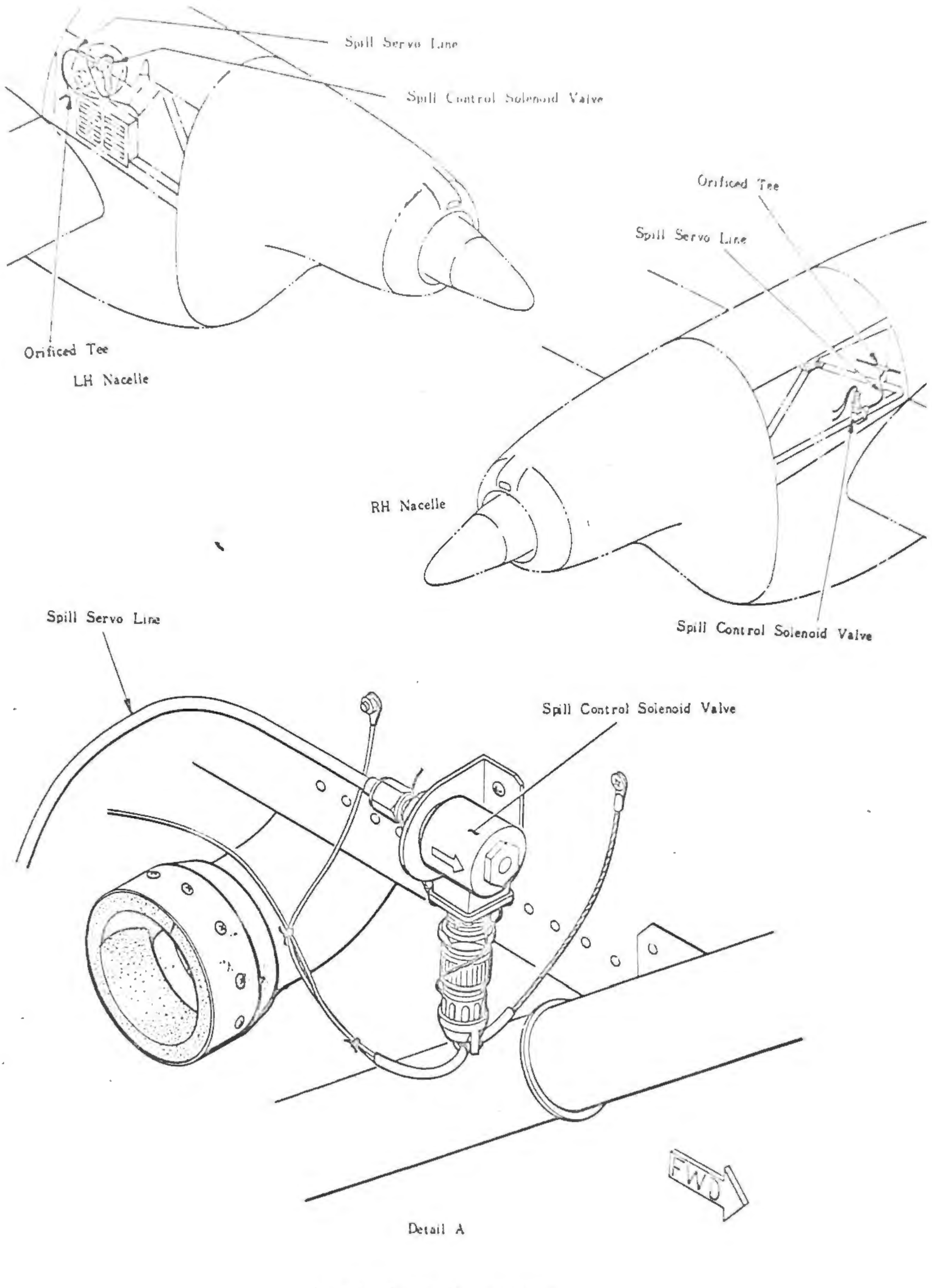
LH Nacelle

RH Nacelle



Cabin Supercharger Differential Pressure Control

Figure 12-11



Spill Control Solenoid Valve
Figure 12-13

(2) Pressure Refueling

Pressure refueling provisions for bag tanks are common to integral tank pressure refueling provisions except that a shut-off valve in the line to the bag tank shall be opened for refueling.
Pressure refueling amount of fuel is as follows:

No. 2	Tank	820ℓ (about 217 U.S. Gal.)	50 U.S. Gal/min.
No. 3	Tank	1,320ℓ (about 349 U.S. Gal.)	50 U.S. Gal/min.

5.8.4 Fuel Feeding System (See Fig. 5-1)

(1) Transfer Line

One fuel transfer pump is mounted on one of the cells in each tank. Fuel in the bag tank is transferred as shown below.

No. 2 Tank ⟶ No. 1 Tank ⟶ No. 1 Engine
No. 3 Tank ⟶ No. 4 Tank ⟶ No. 2 Engine

In the transfer line is located the pressure switch which indicates the completion of fuel transfer from bag tanks to main tanks or the presence of any trouble in the transfer pump. In this case, the fuel empty warning light (Red) located at the shoulder of the fuel quantity indicator on the instrument panel in front of the copilot seat comes on.

Fuel transfer is performed by driving the transfer pump and controlled mechanically by the fuel level control valve in accordance with fuel level change in the integral tank. The fuel level control valve is installed in the integral tank at the extreme point of the fuel line from the bag tank to the integral tank, and functions automatically to stop fuel transfer when the fuel level in the integral tank reaches the full point and start fuel transfer when the fuel level drops.

(2) Bag Tank Vent Line

The bag tank vent is led to the integral tank expansion space. The bag tank vent line running toward the wing tip behind the rear spar of the wing enters the integral tank passing through the rear spar at around W STA 9200 to vent the air inside. The bag tank is provided with an auxiliary vent line, which extends from the tank ceiling and joins the above-mentioned main vent line.

(3) Pipes

Sizes of the pipes used in the bag tank system are as follows.

Transfer Line	1 inch dia.
Vent Line	Main 1 inch dia. Aux 1/2 inch dia.
Pressure Refueling Line	1 inch dia.

Chapter 12 AIR CONDITIONING SYSTEM

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12.2.4 Spill System

(1) Spill Operation and its Conditions

a. General Description of Operation

As safety equipment to protect the engine, supercharger and cooling turbine and to limit the delivery rate, there are a spill valve and a spill control servo system which controls its operation.

"AUTO" or "MANUAL" spill control is accomplished by a by-pass duct and spill valve provided near the outlet of the supercharger.

The spill valve, which is pneumatically operated, leads bleed air (approx. 70 psi) taken from the 2nd stage of the engine compressor to the spill valve control pressure regulator where it is adjusted to 11.0±1.0 psi before delivery to the spill servo pressure line.

This pressure line is connected to four valves, each coupled with a vent hole which is open to the outside atmosphere. When various conditions described later are met, the valve mechanisms concerned are actuated and the spill servo pressure line is connected to the vent hole.

As a result, the pressure of the servo pressure line can no longer be maintained at 11.0±0.1 psi so that the spill valve connected to one of the line is opened to let air on the outlet side of the supercharger escape into the atmosphere.

As long as the servo pressure line maintains 11.0±0.1 psi, this spill valve is kept in "closed" position.

b. Conditions under which the Spill Valve is "Open"

	Purpose	Unit in action	Setting value	Operation	Remarks
1	Supercharger protection	ΔP control	12.5 ~ 13.0 psi or more	Spill control servo pressure	
2		Thermo valve	195°C or more	"	
3	Max. cabin air-flow limiting	Max flow control	75.2$\sqrt{\rho}$ lb/min or more	"	Only port side spills. (ρ=air density)
4	Cooling turbine protection	Thermo S.W. (Comp. outlet)	163°C or more	Electric	Only starboard side spills. (After spilling, depress reset switch.)
5		Thermo S.W. (Comp. inlet)	110°C or more	"	Only port side spills. (After spilling, depress reset switch.)
6	Engine protection	Solenoid valve is controlled electrically to open spill valve. ↓ "OPEN"	14,800 rpm or more	"	When conditions described on the left are met, opposite side spills. (Because of single-engine flight)
7			Fuel flow 380±20 lb/hr or less	"	Low stop lever at "Ground"
8	Prevention of engine fire propagation		EMER. Shut Off HANDLE "PULL"	"	
9	Manual spill		Spill SW "MANUAL"	"	

If the W/M master switch is set to "ON" to operate the water-methanol system apart from the above-mentioned conditions, the W/M purge valve is actuated which purges bleed air containing water-methanol from the engines into the atmosphere so that the pressure source of the spill servo pressure line is interrupted and the spill valve opened, thereby preventing air containing harmful water-methanol from entering the cabin and cockpit through the air conditioning system.

(2) Spill Valve

It is a valve of 2.5 inches in diameter consisting of a diaphragm assembly and a valve mechanism. When there is no pressure in the servo pressure line, the valve is maintained in "opened" position by a spring. If the servo pressure line is actuated, however, the atmospheric pressure and the spring pressure act on one side of the diaphragm, while 11.0±0.1 psi of the spill servo pressure line acts on the opposite side so that it is balanced and kept stationary at "CLOSE" position but if this pressure drops even a little, the balance is lost, the spring stretched, and the valve placed in "OPEN" position.

A micro switch is located in the arm which links the diaphragm and the valve mechanism. If the valve is placed in a position less than 5° of the fully-opened position, the contacts of the micro switch are closed to light the spill valve indicating light on the cockpit RH side console, indicating that the valve is "OPEN".

(3) Spill Servo Pressure Regulator

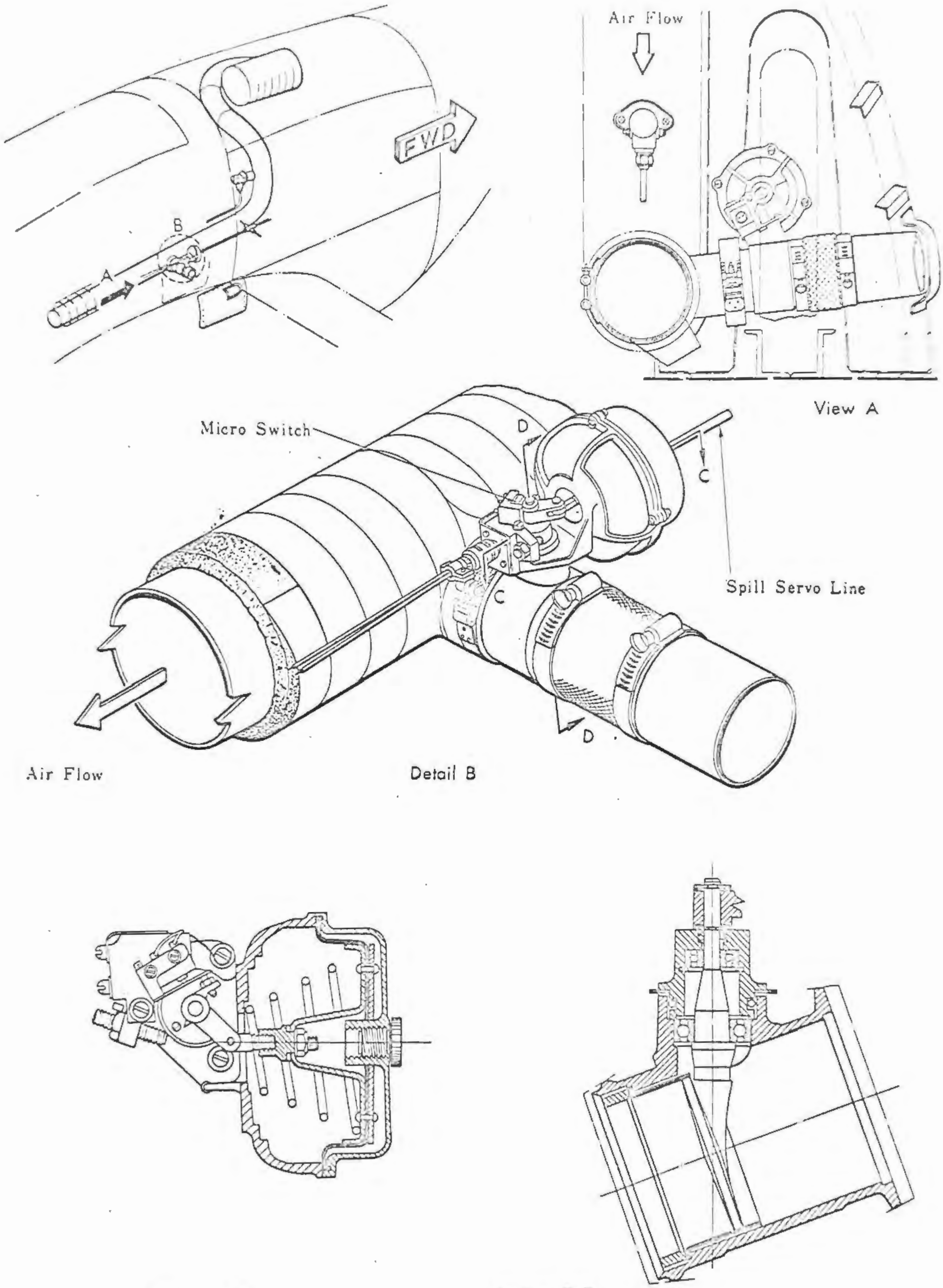
It consists of a diaphragm assembly and a metering valve.
One side of the diaphragm is connected to the atmosphere. The diaphragm is held down by an adjusting screw with a spring in between. On the opposite side is provided a regulated pressure chamber which is connected to the engine bleed air (approx. 70 psi) inlet port and the output port to the spill servo pressure line (11.0±0.1 psi) through the metering valve mechanism.
The delivery pressure is adjusted by spring tension.

(4) ΔP (Differential Pressure) Control

It consists of a spring-loaded diaphragm assembly and a metering valve. ΔP is controlled by adjusting the tension of the spring connected to the diaphragm by the adjusting screw.

The diaphragm assembly consists of two diaphragms, steady-state and transient.

On one side of the steady-state diaphragm, the spring tension and the inlet side pressure of the supercharger act through the low pressure sensing port. The outlet side pressure of the supercharger acts on the transient diaphragm through the high pressure sensing port.



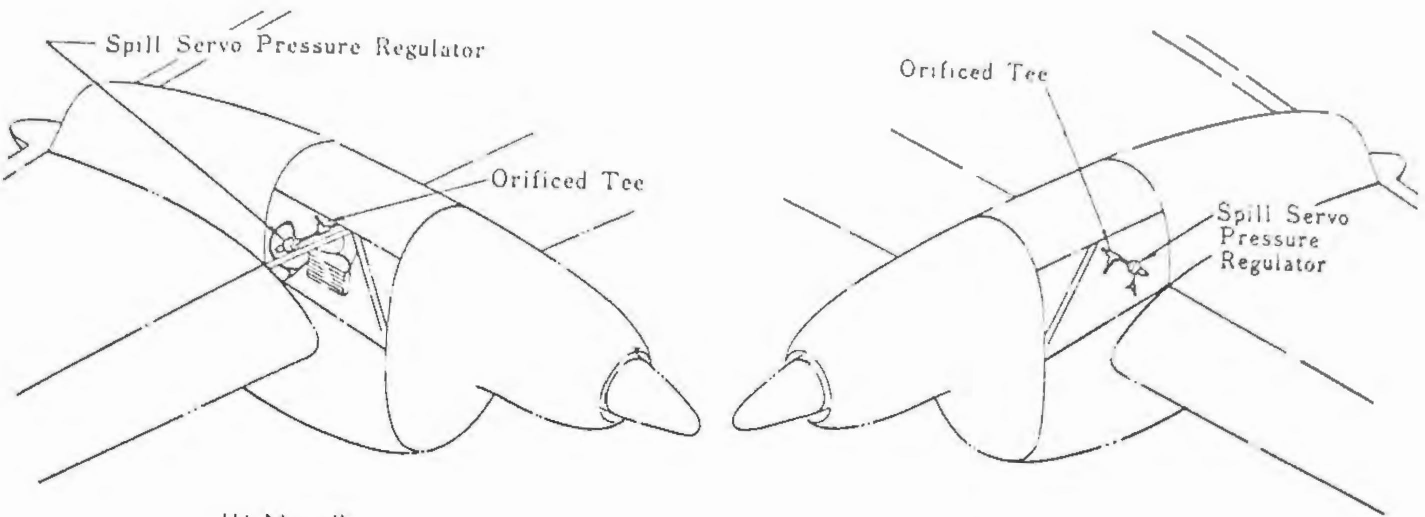
View A

Detail B

Section C-C

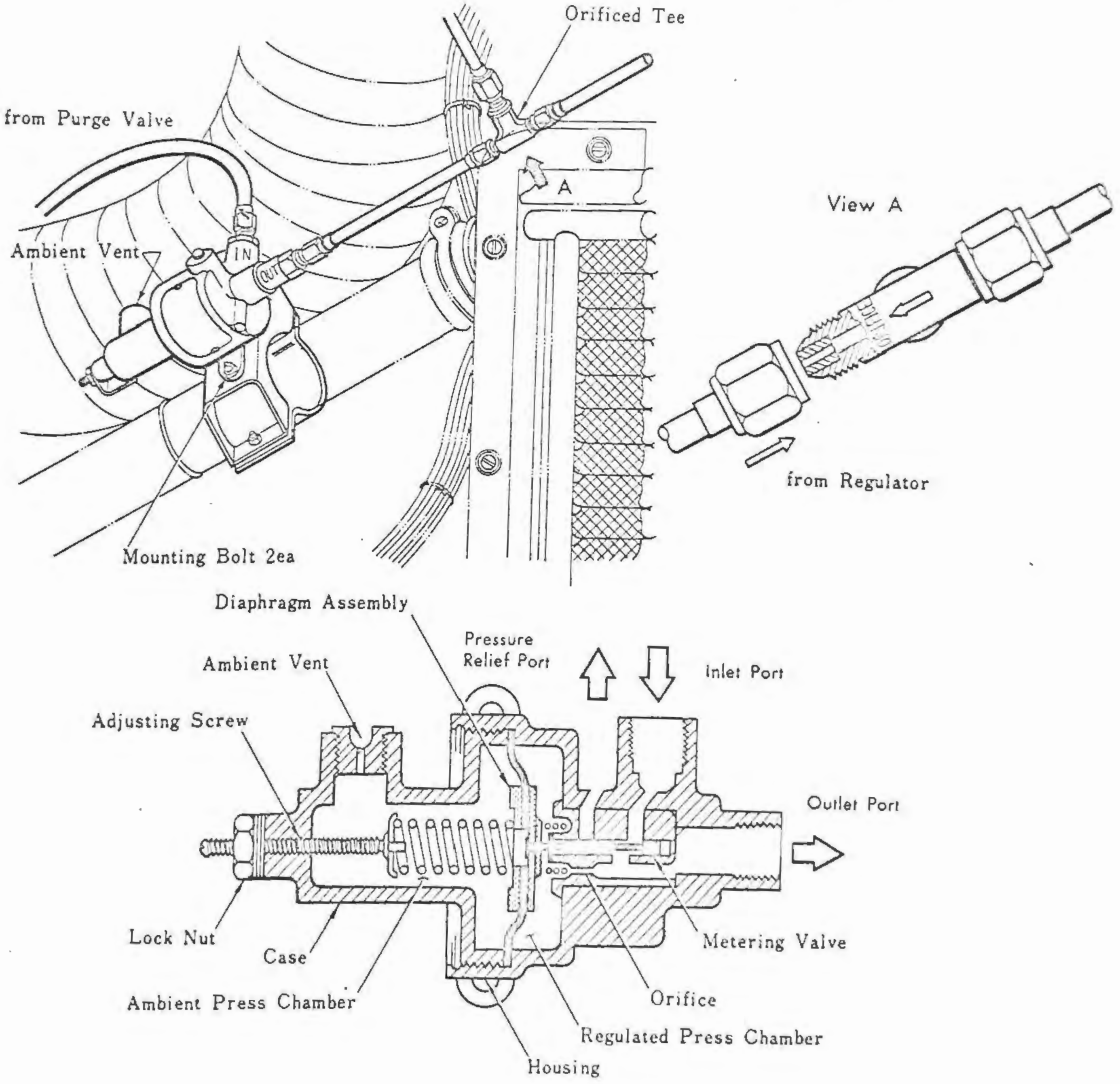
Section D-D

Spill Valve
Figure 12–9


Spill Servo Pressure Regulator
Orificed Tee
Orificed Tee
Spill Servo Pressure Regulator

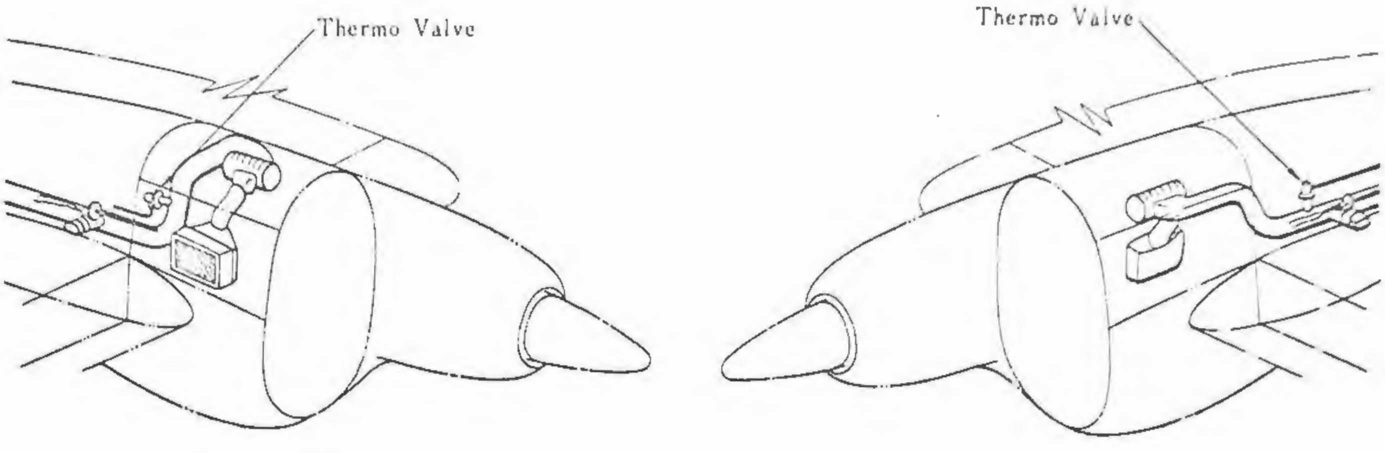
LH Nacelle

RH Nacelle

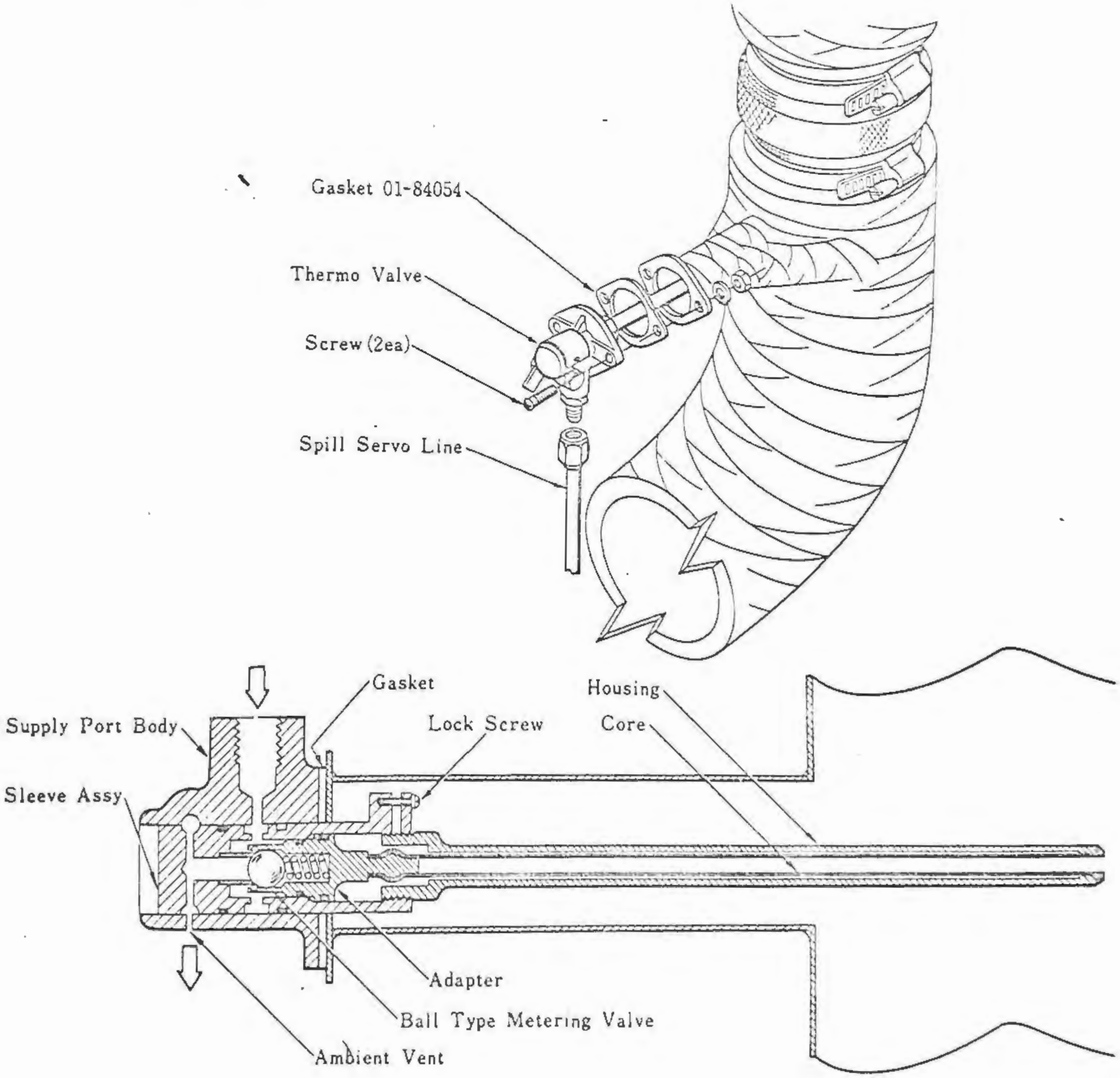


Spill Servo Pressure Regulator

Figure 12-10

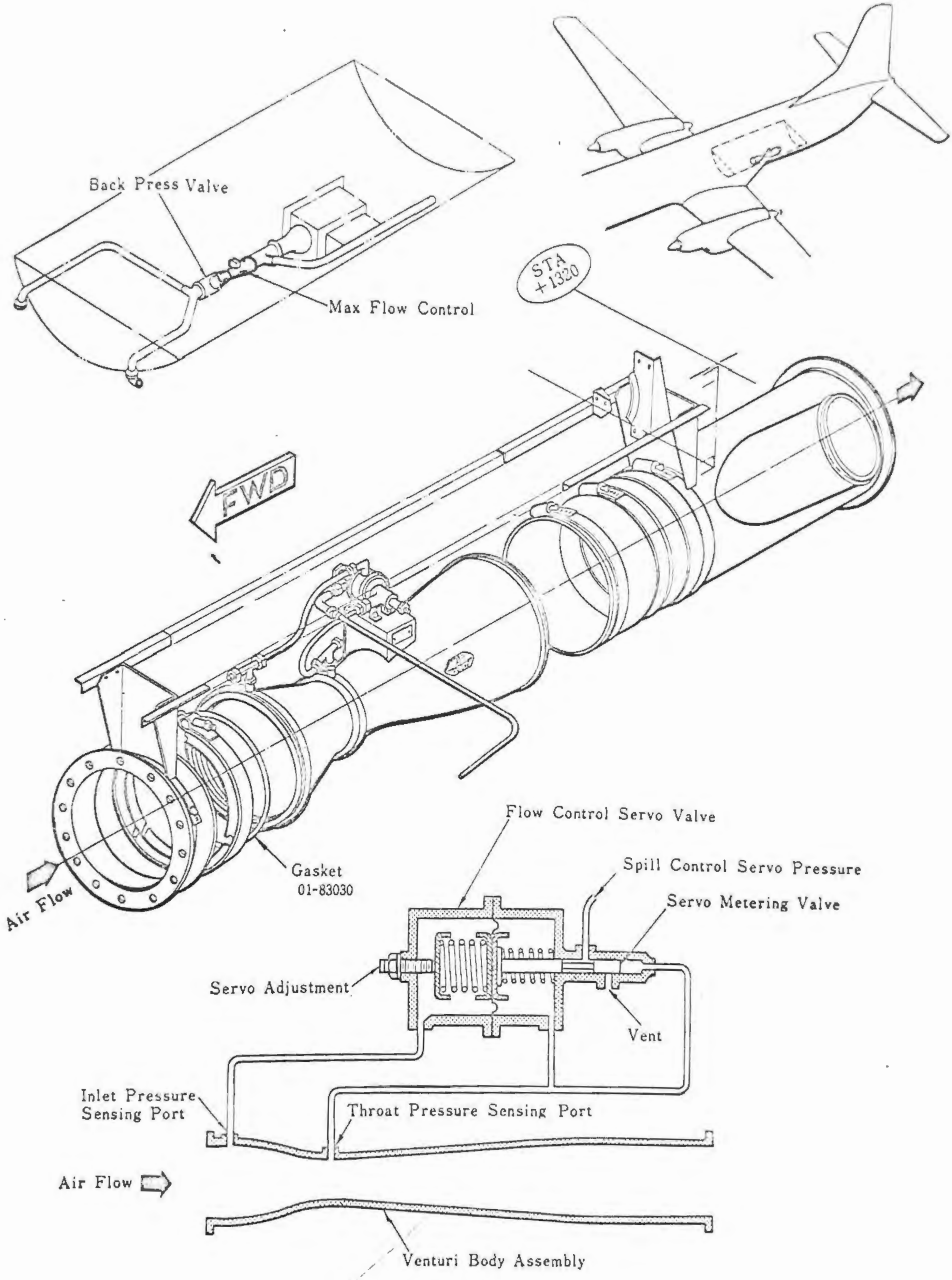


LH Nacelle RH Nacelle



Cabin Supercharger Thermo Valve

Figure 12-12



Max Flow Control

Figure 12-14

12.2.5 Indicators

As indicators for the compression and spill system is provided with the cabin supercharger discharge air indicator and spill valve indicating light located in the copilot RH side console.

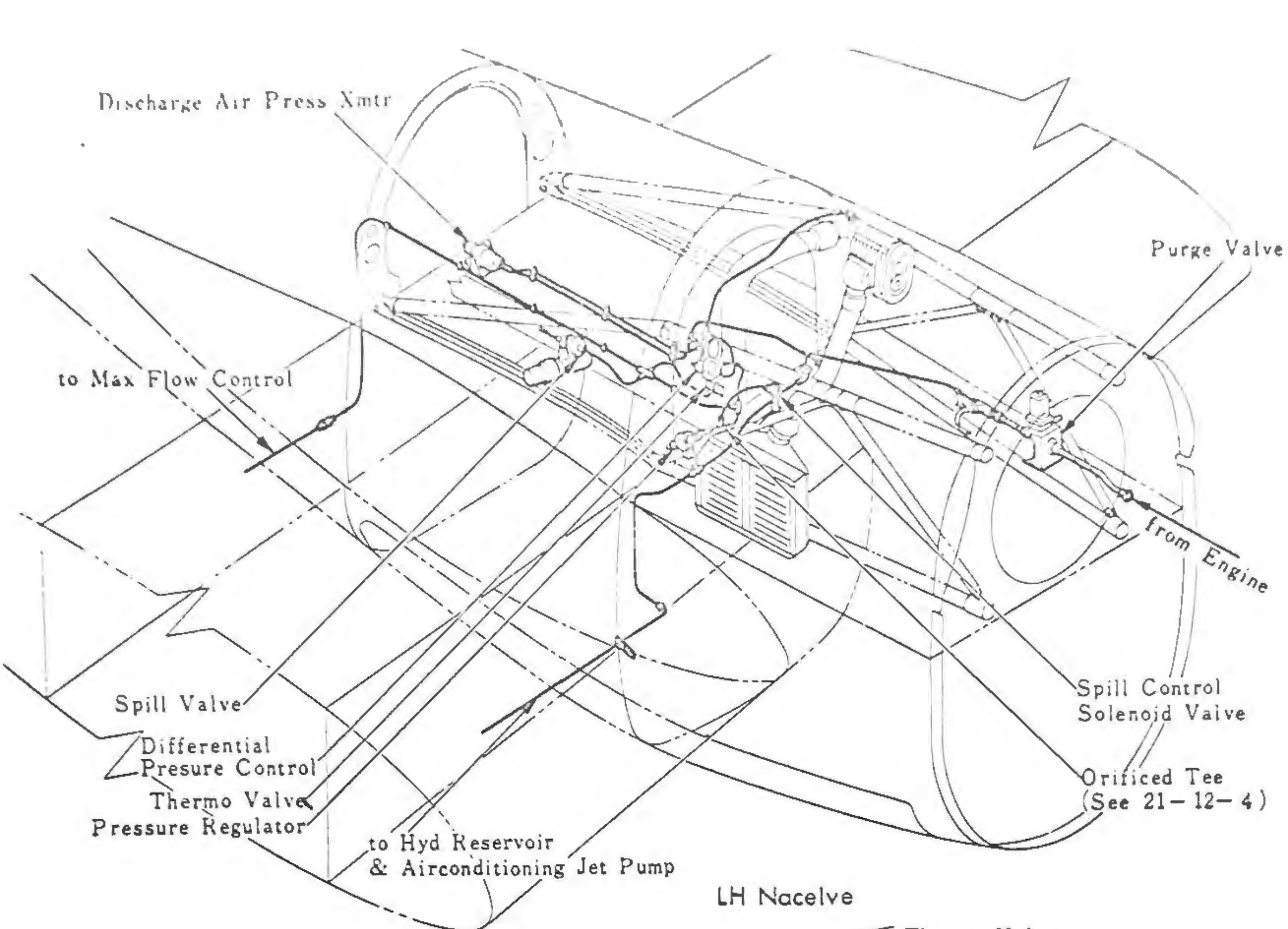
(1) Cabin Supercharger Discharge Air Pressure Indicator

This is an AC synchro type (26V 400c/s AC) two-pointer pressure indicator which indicates differential pressure signals received from transmitters mounted in parallel with the ΔP control on the inlet and outlet sides of the right and left superchargers.

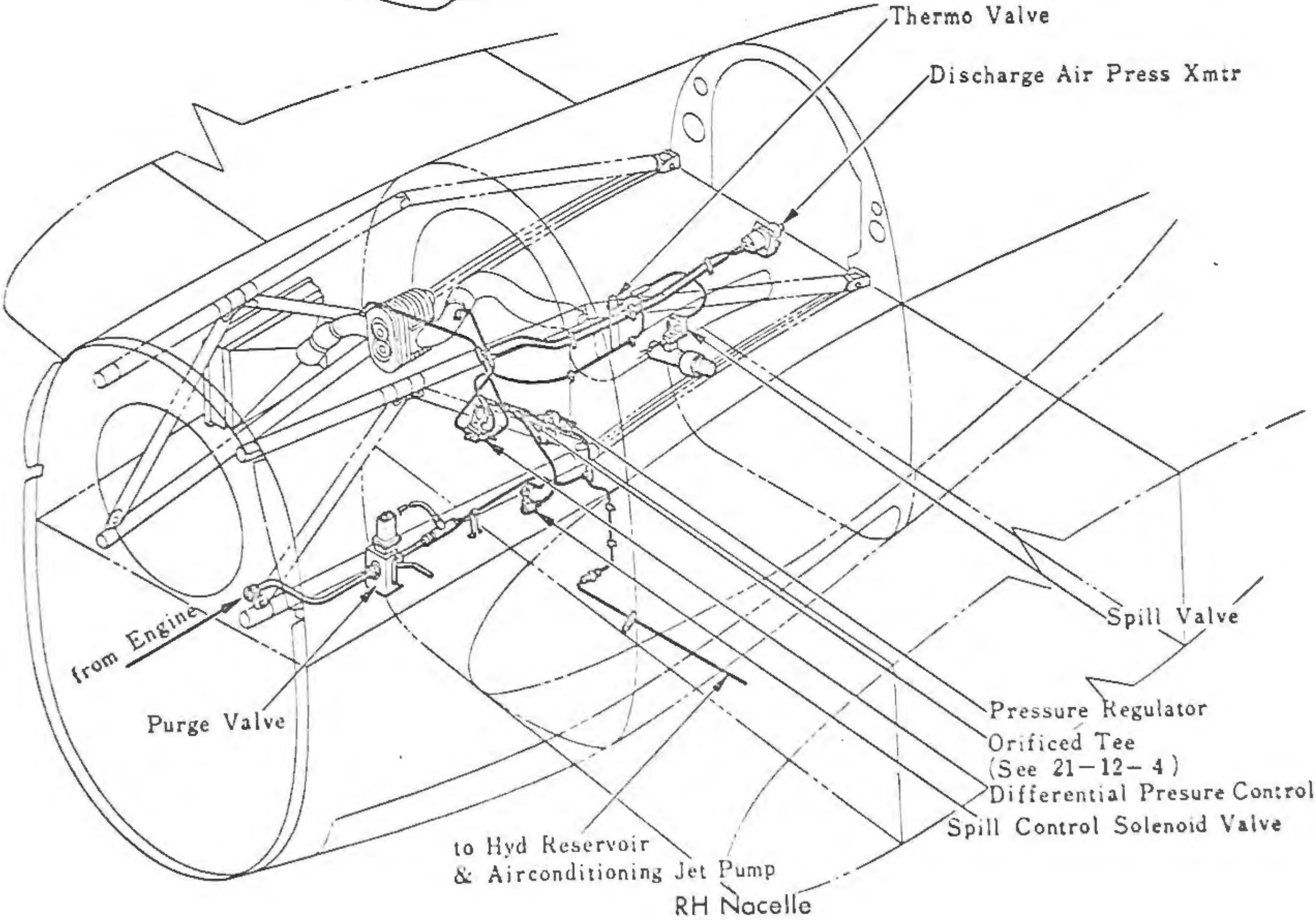
The pointers 1 and 2 indicate the left and right systems respectively.

(2) Spill Valve Indicating Light

One amber light each is provided for the right and left spill valves. When the spill valve is opened, the micro switch mounted on the spill valve is set to "ON" so that the light comes on, indicating that air is being spilled.



LH Nacelve



RH Nacelle

Spill Control & Indicating system
Figure 12–15

12.3 Cooling System

12.3.1 System Operation

Combined air flow from the right and left superchargers is divided into two flows again. One of them passes through a cooling system which consists of the primary heat exchanger, secondary heat exchanger, cooling turbine and water separator, to produce cold air (0.6°C).

This cooling system is of the so-called "boot-strap type" in which the pressure of air to be cooled is raised by a compressor and the temperature lowered through adiabatic expansion by an expansion turbine.

The pressure ratio of the roots type supercharger is so low that the temperature cannot be lowered efficiently by the cooling turbine. High-temperature and medium-pressure air flow delivered from the supercharger is led to the primary heat exchanger where the temperature alone is lowered without lowering the pressure and is then delivered to the compressor stage of the cooling turbine which raises the pressure.

At this point, however, the temperature also rises because of compression and friction heat which increases with pressure so that air flow from the compressor stage is cooled again by a secondary heat exchanger which lowers the increased temperature. At the same time, the expansion turbine is driven by this air flow, lowering the temperature through adiabatic expansion. In addition, the temperature is lowered by the amount of energy which is used to drive the compressor.

At this point, the air flow let out from the turbine is cooled rapidly so that water drops are formed. For this reason, a water separator and water separator duct are provided to separate and drain water drops outside the aircraft.

Furthermore, an electrically controlled and hydraulically operated ground cooling system is provided for use as an auxiliary equipment when sufficient ram air cannot be obtained for cooling the heat exchanger, for example, when the aircraft is on the ground.

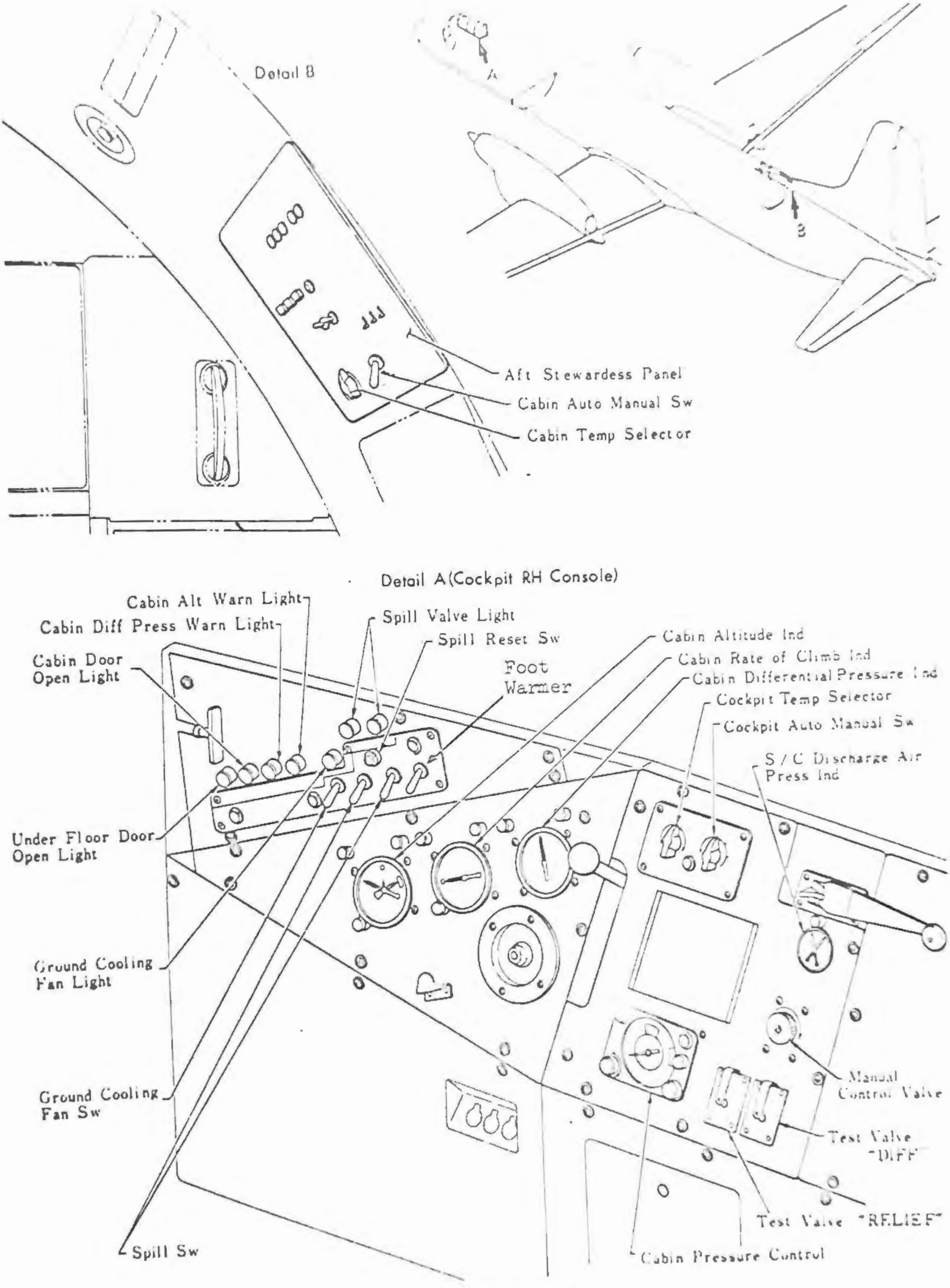
12.3.2 Main Components

(1) Cooling Turbine

Type:	Boot strap type
RPM:	39,000 rpm (max.)
Outlet air temperature:	0.6°C (33.0°F max.)
Flow air weight:	87.0±4.0 lb/min (sea level)
Lubricant:	MIL-L-6085
Oil capacity:	524 cc

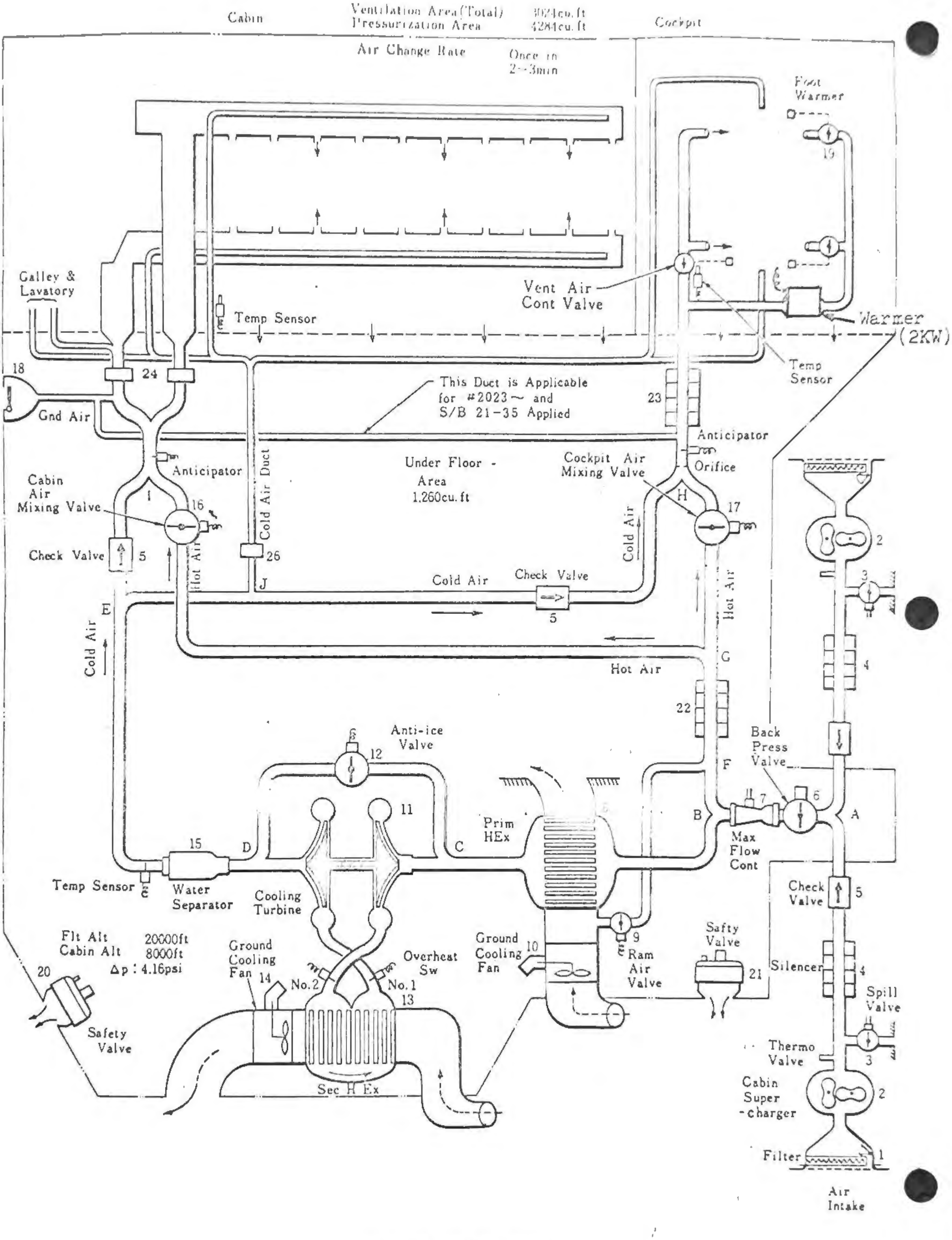
(2) Ground Cooling Fan

RPM:	10,000 rpm (max)
Flow max.:	2.5 gal/min



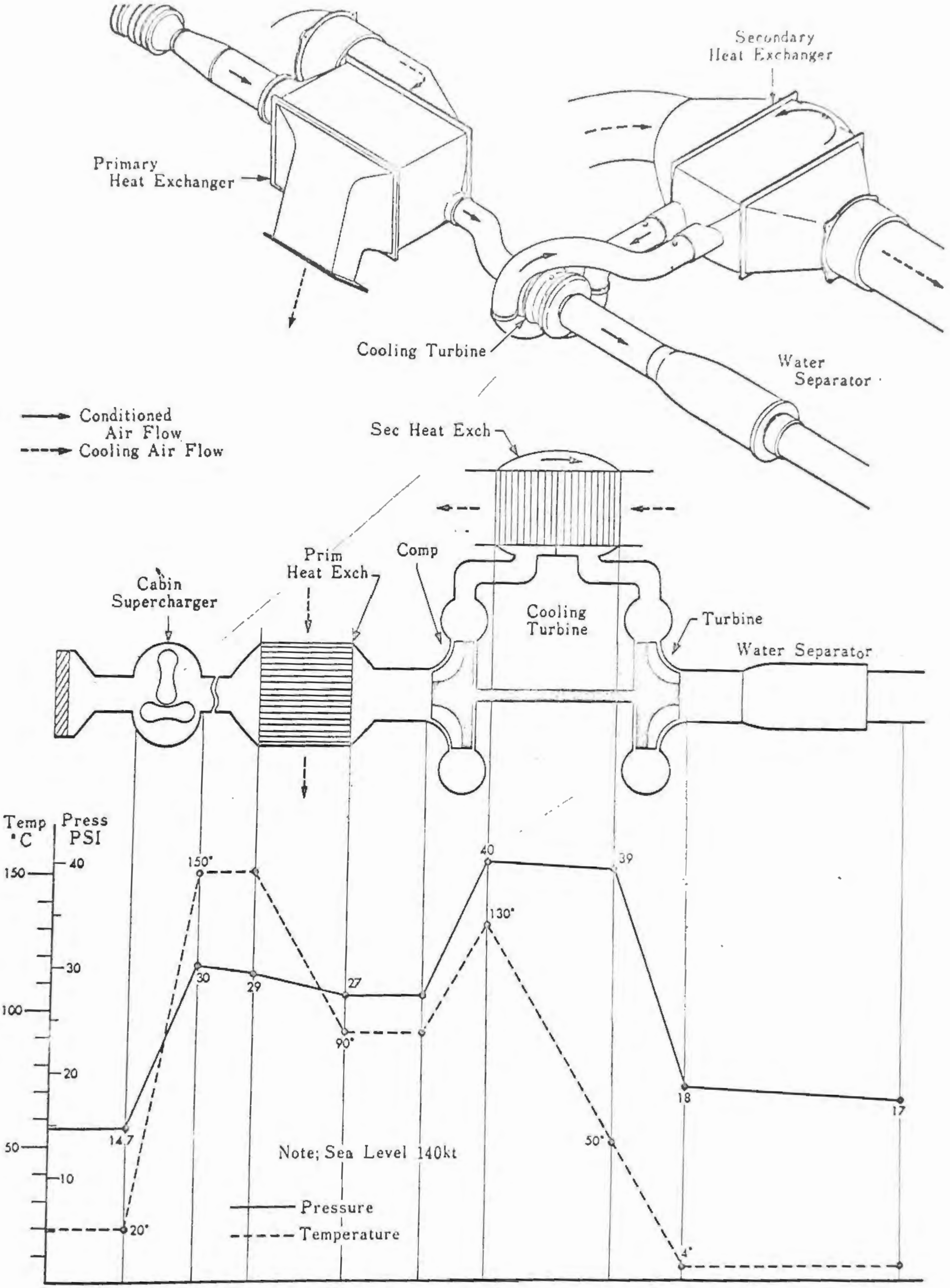
Air Conditioning Controls

Figure 12-16



Air Conditioning System

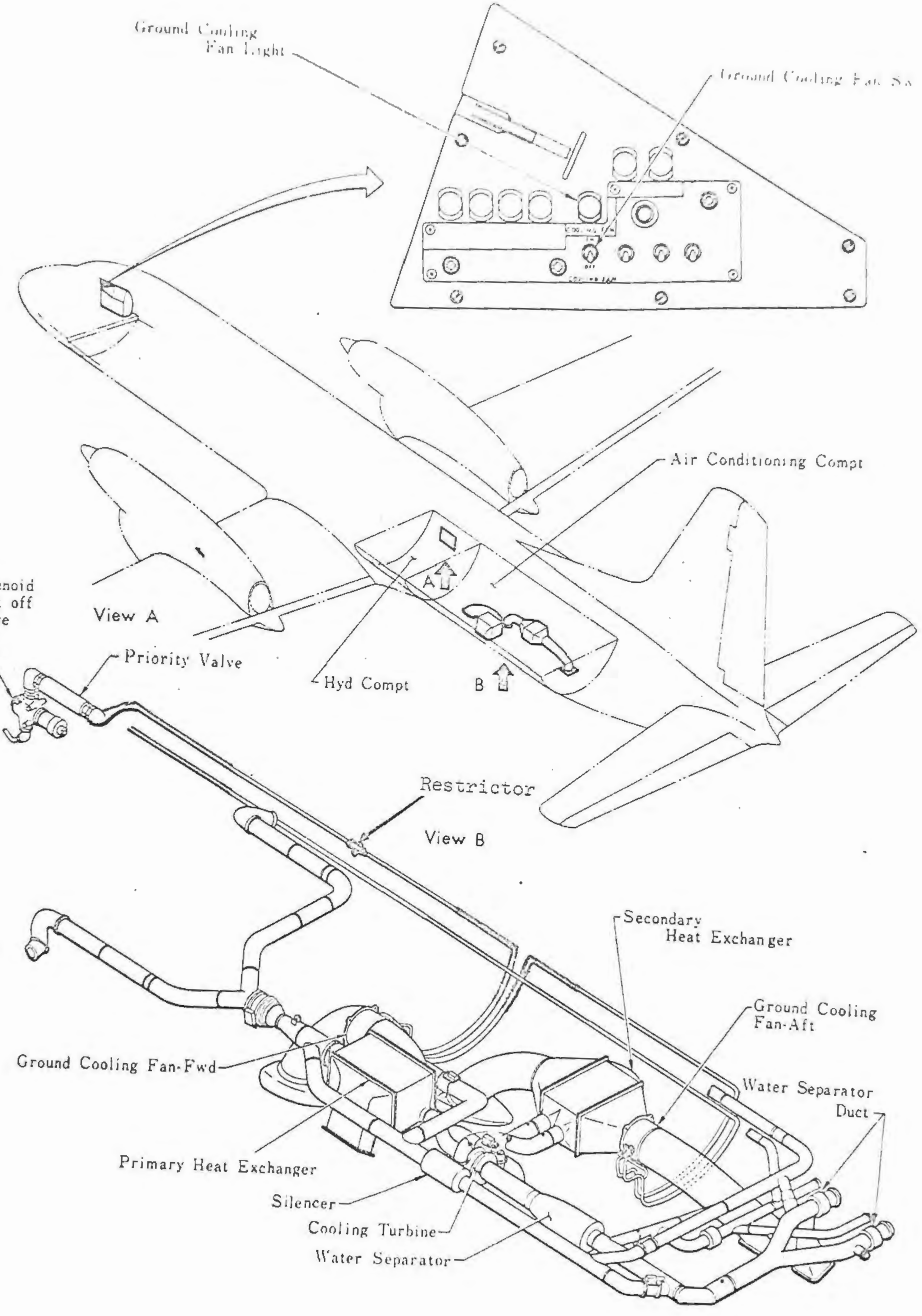
Figure 12-17



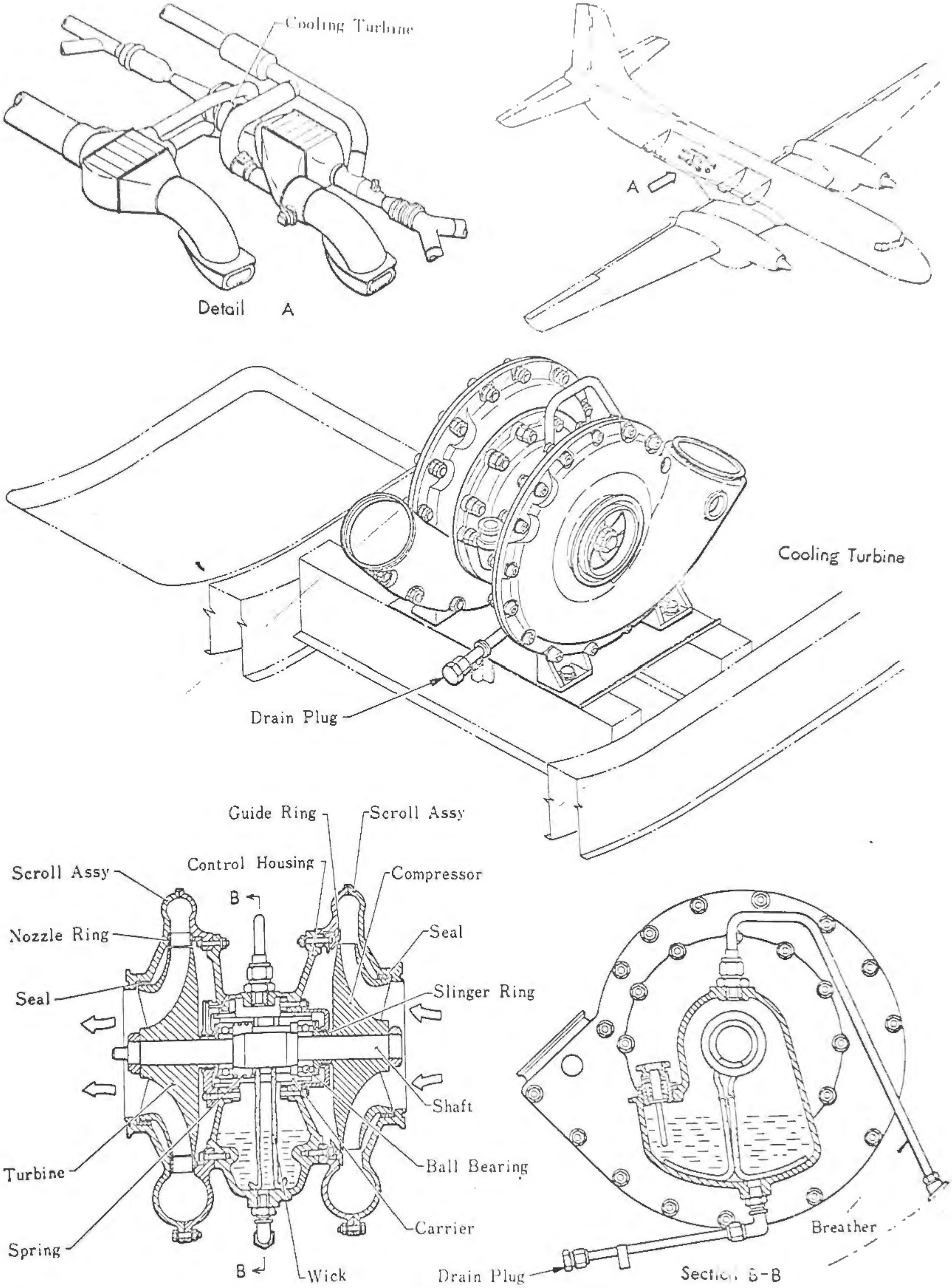
Temperature & Pressure Distribution (Example)

Normal Cooling System

Figure 12–18



Cooling System Arrangement
Figure 12-19



Cooling Turbine
Figure 12-20

(At present, the RPM is limited to 5,800 rpm to suppress noise.)

12.3.3 Cooling Turbine

This turbine unit consists of a centrifugal type compressor and a radial flow type expansion turbine connected together with a shaft. Between the compressor and the turbine, are located a wick type lubricating oil sump and a servicing inlet. There is also a dip stick to check oil level.

12.3.4 Primary Heat Exchanger

This is an air-to-air cooling system and is located in the front part of the air conditioning compartment. From the ram air scoop in the bottom surface of the fuselage, it circulates ram air (cooling air) corresponding to the aircraft speed round the many thin tubes through which hot air flows, thereby lowering its temperature, and lets the air escape toward the left side of the airframe. The hot air in this case circulates in a single-path, flowing in from one side of the thin tubes and getting out from the other side. When the aircraft is stationary on the ground or during taxiing, ram air corresponding to the aircraft speed as in flight cannot be obtained so that cooling air is obtained by a ground cooling fan driven by a hydraulic motor mounted on the ram air scoop.

12.3.5 Secondary Heat Exchanger

It is of the same type as the primary heat exchanger but is internally divided into two halves. As a matter of fact, it is of double path type in which hot air (conditioned air) first flows in from the inlet side of the latter half, makes a "U" turn inside, and gets out in cooled air flow from the outlet side just before the inlet opening.

The ground cooling fan is located in the rear of the heat exchanger in contrast with the primary exchanger.

12.3.6 Water Separator

The system is provided with a water separator and a water separator duct.

(1) Water Separator

This is a kind of centrifugal type water separator in which cold air containing moisture from the cooling turbine is swirled and is given rotary motion to utilize its centrifugal force to collect and drain heavy moisture outside the aircraft.

When the water separator is frozen or when the surface of the fiberglass condenser is frozen because of moisture, the temperature condenser located near the outlet senses a temperature below 0°C and opens the anti-ice valve through which hot air by-passing the cooling turbine and secondary heat exchanger is circulated, preventing icing.

In the center part of the inlet side, a relief valve is located which prevents the condenser from being blocked with foreign substances. The valve is opened when the differential pressure exceeds 4.5±0.5 in-Hg.

(2) Water Separator Duct

This is a petal-cone type separator which catches and drains moisture which cannot be fully separated by the water separator. One duct is provided for the cold line and two for the condition line.
The duct is of conical construction consisting of six petals against which conditioned air is blown to rotate them and to utilize their centrifugal force to separate the remaining moisture.

12.3.7 Ground Cooling Fan System

(1) Ground Cooling Fan

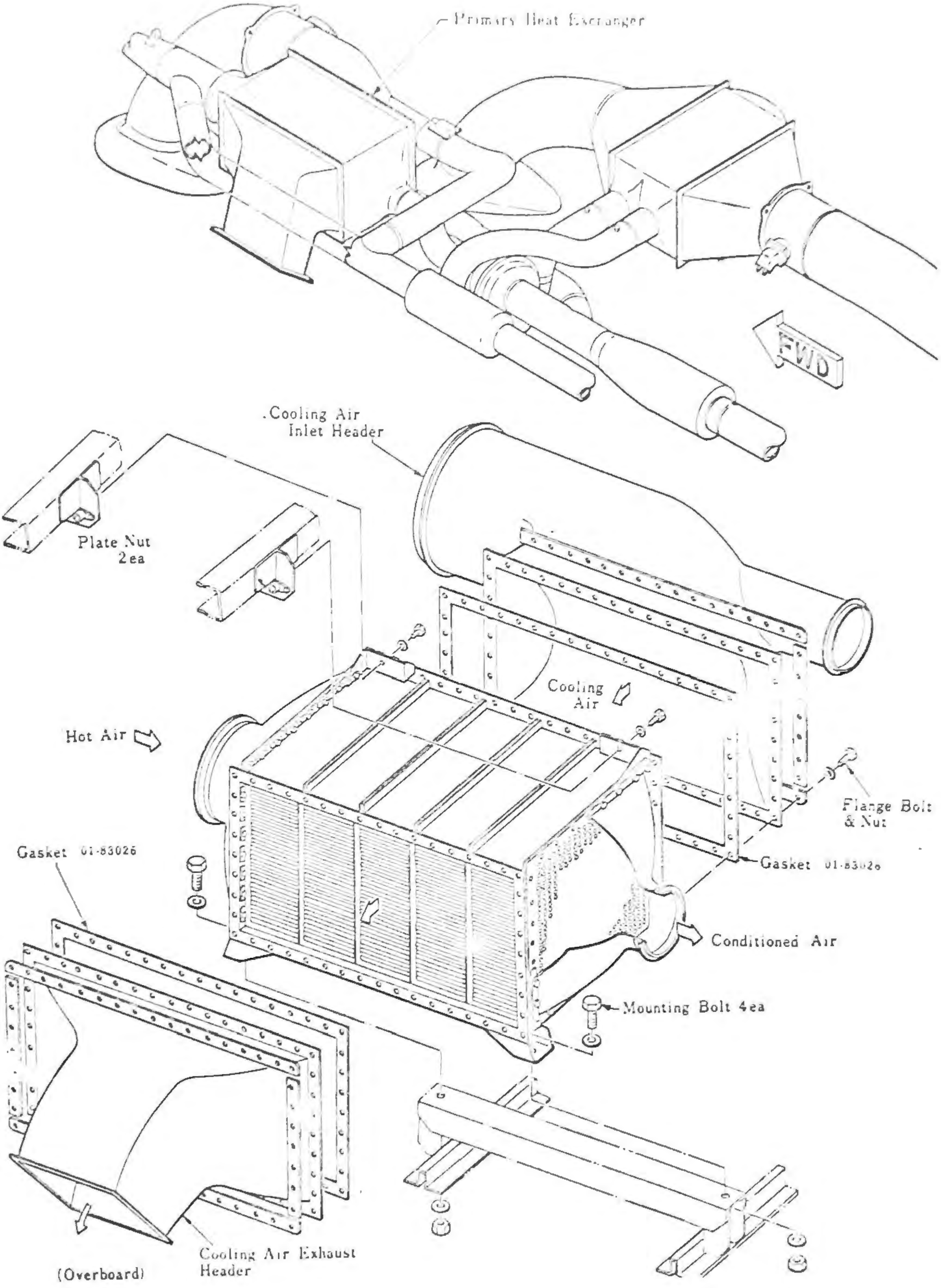
One cooling fan each is located on the inlet side of the ram air duct for the primary heat exchanger and on the outlet side for the secondary heat exchanger. It is a hydraulic motor driven fan operated by the ground cooling fan switch on the cockpit side console.

It consists of a hydraulic motor, clutch assembly, oil level gage assembly and fan shaft housing assembly. The fan speed is 10,000 rpm max. At present, however, the speed is limited to 5,800 rpm by restricting the rate of flow to the hydraulic motor in order to reduce noise.

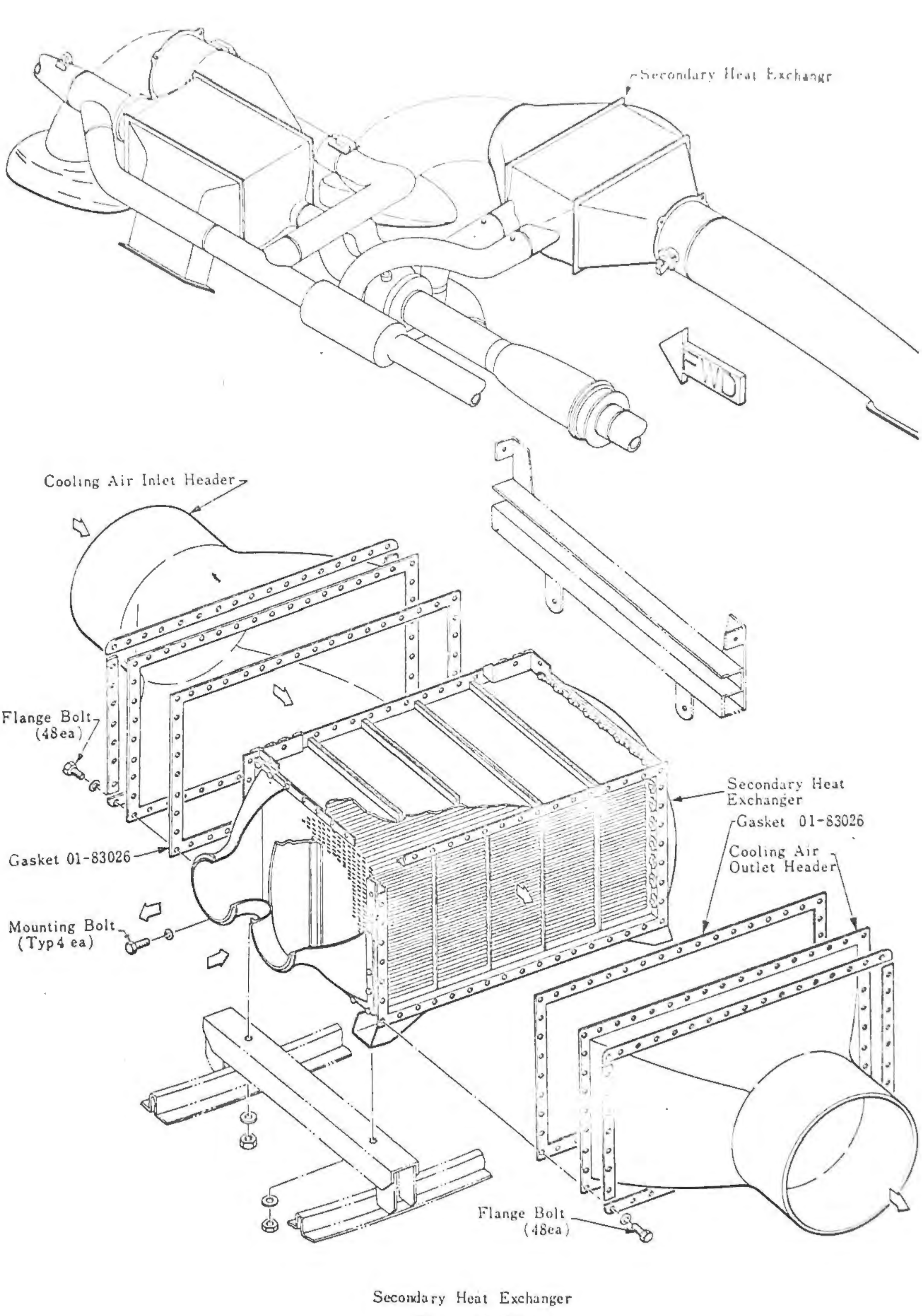
Even if the hydraulic motor is not operative with the switch turned "OFF", if ram air is blowing against the fan as in flight, the fan continues idle running in wind-milling condition by means of a clutch mechanism.

(2) Ground Cooling Fan Indicating Lights

These "amber" lights are arranged at the lower left of the spill valve light. If the ground cooling fan switch is turned "ON", the lights come on and simultaneously the solenoid shut-off valve is actuated, opening the oil path to the hydraulic motor.

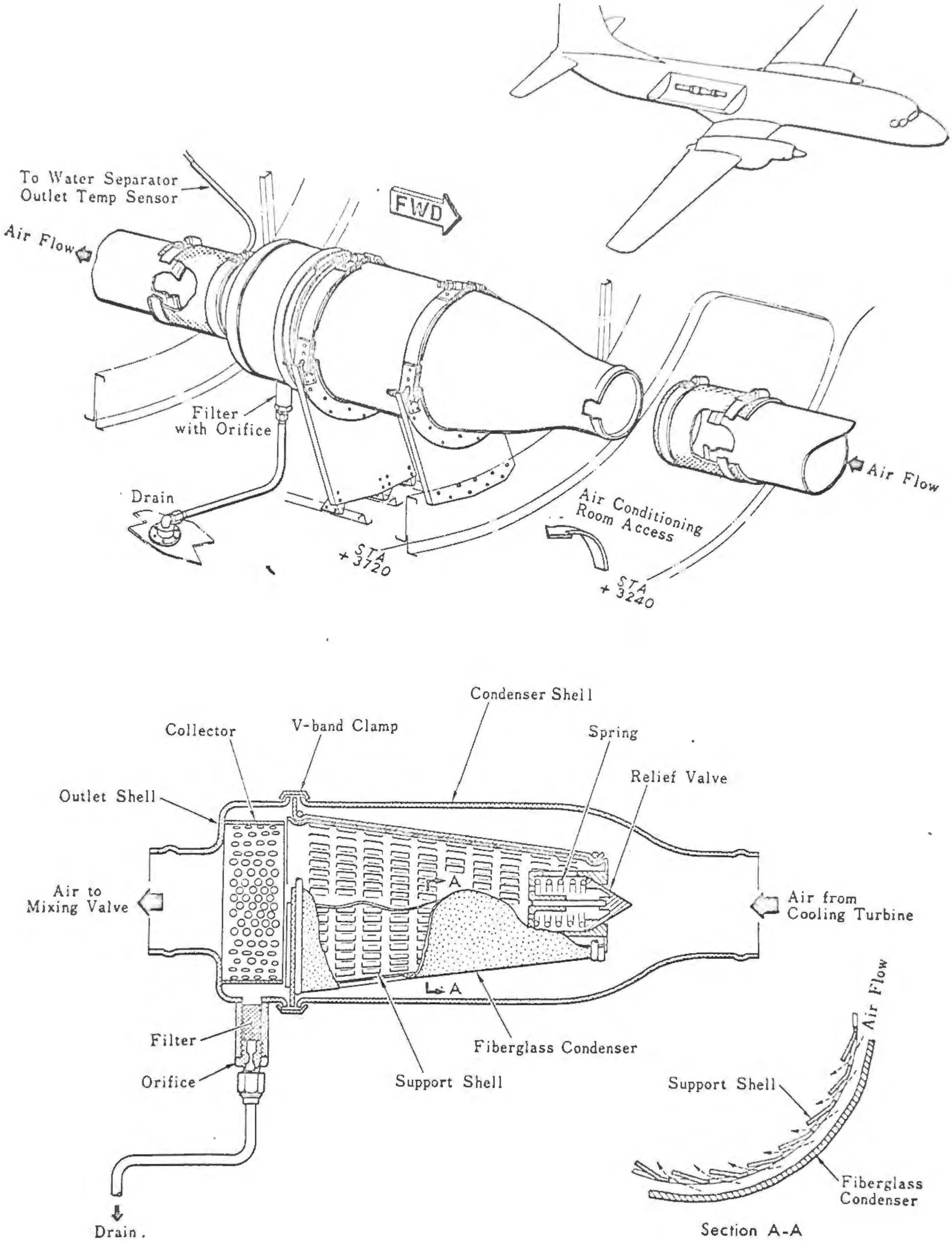


Primary Heat Exchanger
Figure 12-21

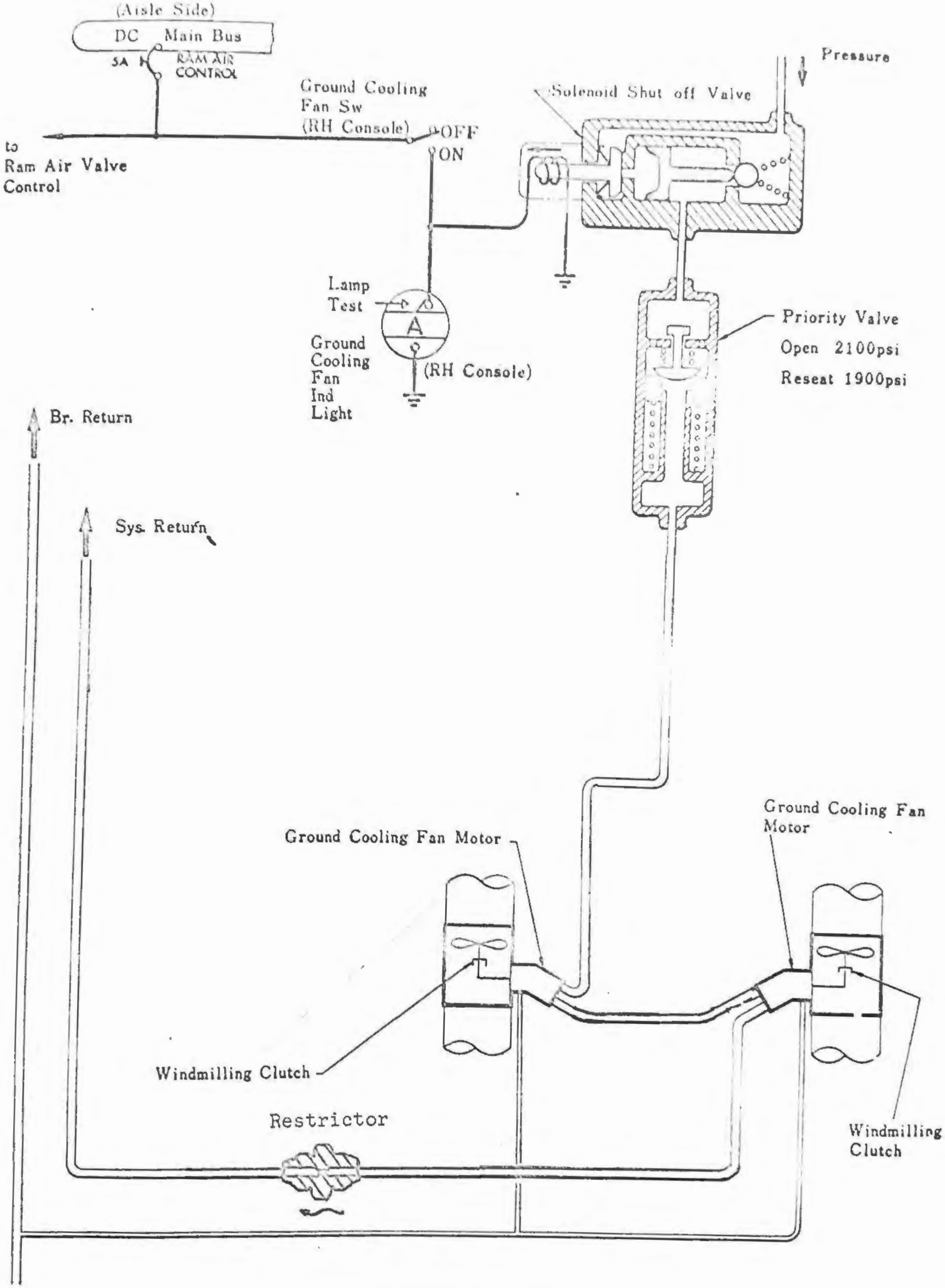


Secondary Heat Exchanger

Figure 12–22

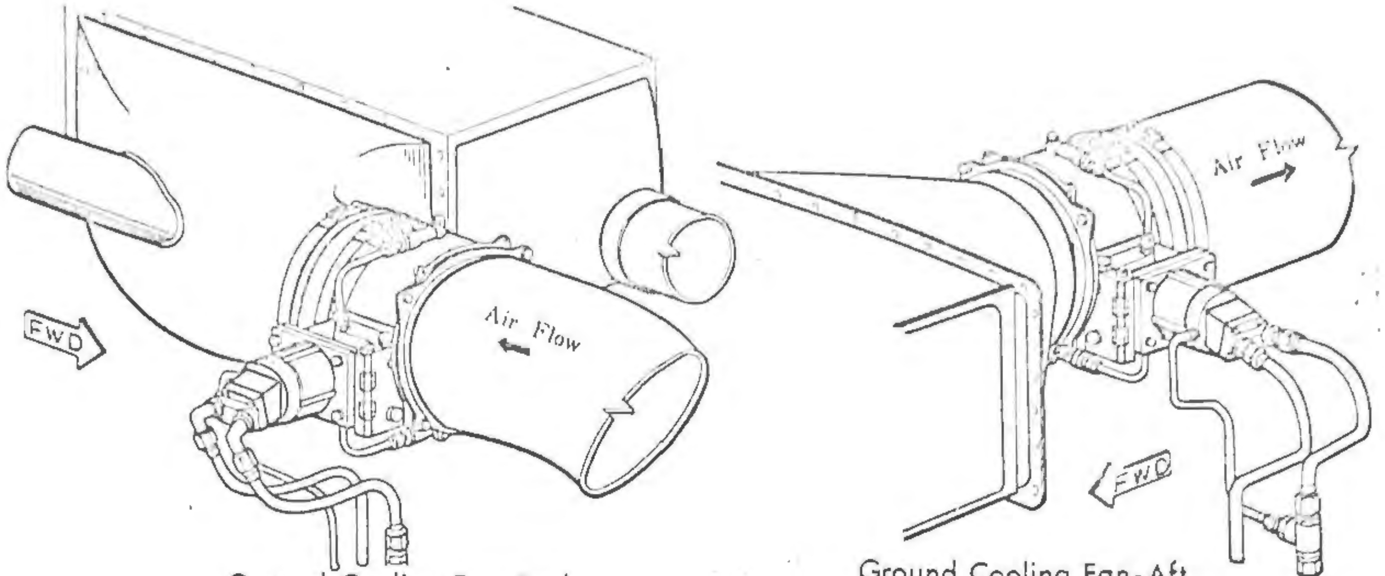


Water Separator
Figure 12–23



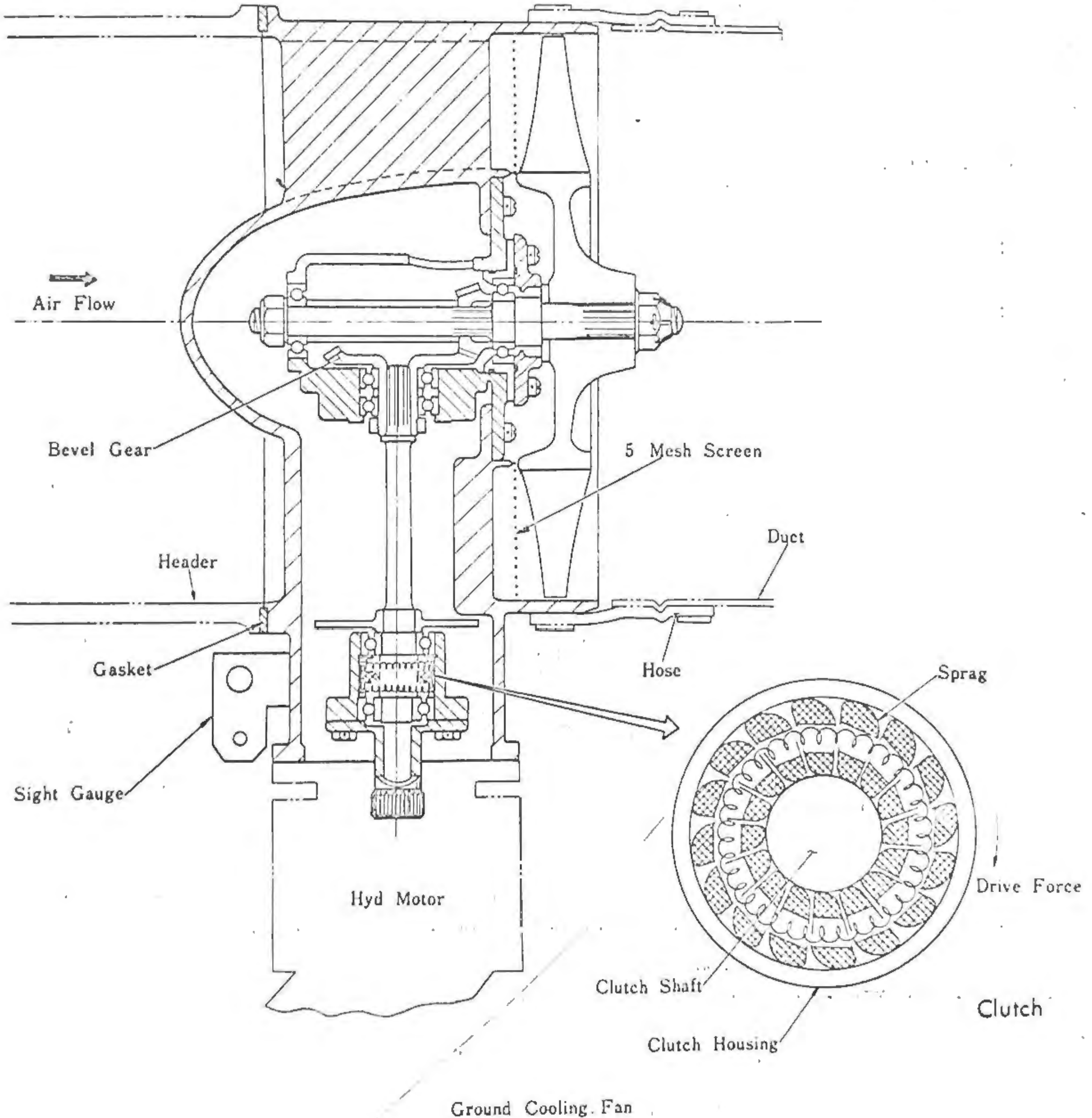
Ground Cooling System Schematic

Figure 12-24



Ground Cooling Fan-Fwd

Ground Cooling Fan-Aft



Ground Cooling Fan

Figure 12–25

12.4 Pressurization System

12.4.1 System Operation

This system controls the opening of the forward outflow valve located in the electric compartment and the opening of the after outflow valve located in the pressure bulkhead of the STA 8080 by means of a pneumatic mechanism to adjust the air pressure of the pressurization area.

As a safety device, if the differential pressure exceeds 4.41±0.1 psi, this outflow valve acts as a safety valve through which air can be relieved.

It is controlled by the copilot who operates the cabin pressure controller located in the copilot side console.

The functions of this system include:

(1) Automatic Pressure Control System

  a. Fixed altitude pressurizing operation

  b. Fixed rate of change operation

  c. Fixed differential pressurizing operation

(2) Manual Pressure Control System

(3) Cabin Pressure Relief System

  a. Positive pressure relief

  b. Suction relief

12.4.2 Main Components

Part Name	Location	EA/SHIP
Cabin Press. Controller	Cockpit Side Console	1
Manual Press. Control Valve	"	1
Outflow & Safety Valve	Elec. Compt. STA8080	2
Pneumatic Relay	"	2
Jet Pump	"	2
Air Filter	"	2
Test Valve	Cockpit Side Console	2

12.4.3 Pneumatic Control System

(1) Pneumatic Pressure Mechanism

Cabin pressure is introduced into the reference chamber of the cabin pressure control through filter orifices. This pressure presses the isobaric bellows located in the control, opens the metering valve, and lowers the internal pressure of this control by means of a jet pump.

If the pressure is brought down to a certain point, the metering valve is closed to stop the internal pressure from being further lowered so that the internal pressure is maintained at a predetermined value. In other words, the opening of the metering valve is automatically varied according to changes in the cabin pressure so that the internal pressure will be maintained almost constant.
This pre-determined value is called reference pressure.
If the spring strength of the isobaric bellows is changed, the reference pressure is also changed correspondingly.

Since this reference pressure is sent to the upper side of two pneumatic relays, the pressure of the upper half of the pneumatic relays may be considered constant at all times, unless the cabin altitude setting is changed.

In the meantime, cabin pressure delivered through the filter orifices of the outflow valve is compared to the reference pressure and metere by the pneumatic relays. For this reason, the pressure of the lower side of the pneumatic relay and the internal pressure of the upper side of the outflow valve are exactly the same as the reference pressure and are always constant, unless the cabin altitude setting is changed.

In this manner, a constant pressure determined by the cabin altitude setting of the control is maintained inside the reference chamber of the outflow valve.

The lower side of the outflow valve into which cabin pressure is fed keeps balance with the sum of the internal pressure of the reference chamber and the spring force.

If the cabin pressure goes up too high, it moves the spring a little upward, increases the opening of the gate valve, and lowers the cabin pressure. If the cabin pressure goes down too much, the gate valve is held back by the spring, reducing its opening, and increasing the cabin pressure.

Namely, the outflow valve like the pneumatic relay is a kind of follow-up pressure regulating valve which accomplishes the function of maintaining the cabin pressure constant according to the reference pressure in the control.

(2) Cabin altitude Setting

The knob for setting the cabin altitude of the cabin pressure control determines the internal pressure of the control.

When balance is maintained in normal condition, if this knob is rotated, the reference pressure of the control is changed and the cabin pressure also correspondingly changed.

A fast change of the cabin pressure gives discomfort to the passengers so that there is a rate system by which the changing speed of the cabin pressure can be regulated.

(3) Rate Operation

There is a diaphragm which divides the interior of the control into two parts. They are interconnected through orifices.

When the reference pressure in the contrl changes to a new setting, the internal pressure of the upper rate chamber changes with a delay which saves the operation of the metering valve.

Because of this function, the reference pressure cannot become equal to the new setting quickly. The change is so slow that the internal pressure of the rate chamber can follow it up.

The follow-up speed can be regulated by the needle valve of the rate knob. The narrower the opening of the needle valve, the slower the speed of change.

(4) Isobaric Bellows

This unit maintains the reference pressure (cabin pressure) constant.

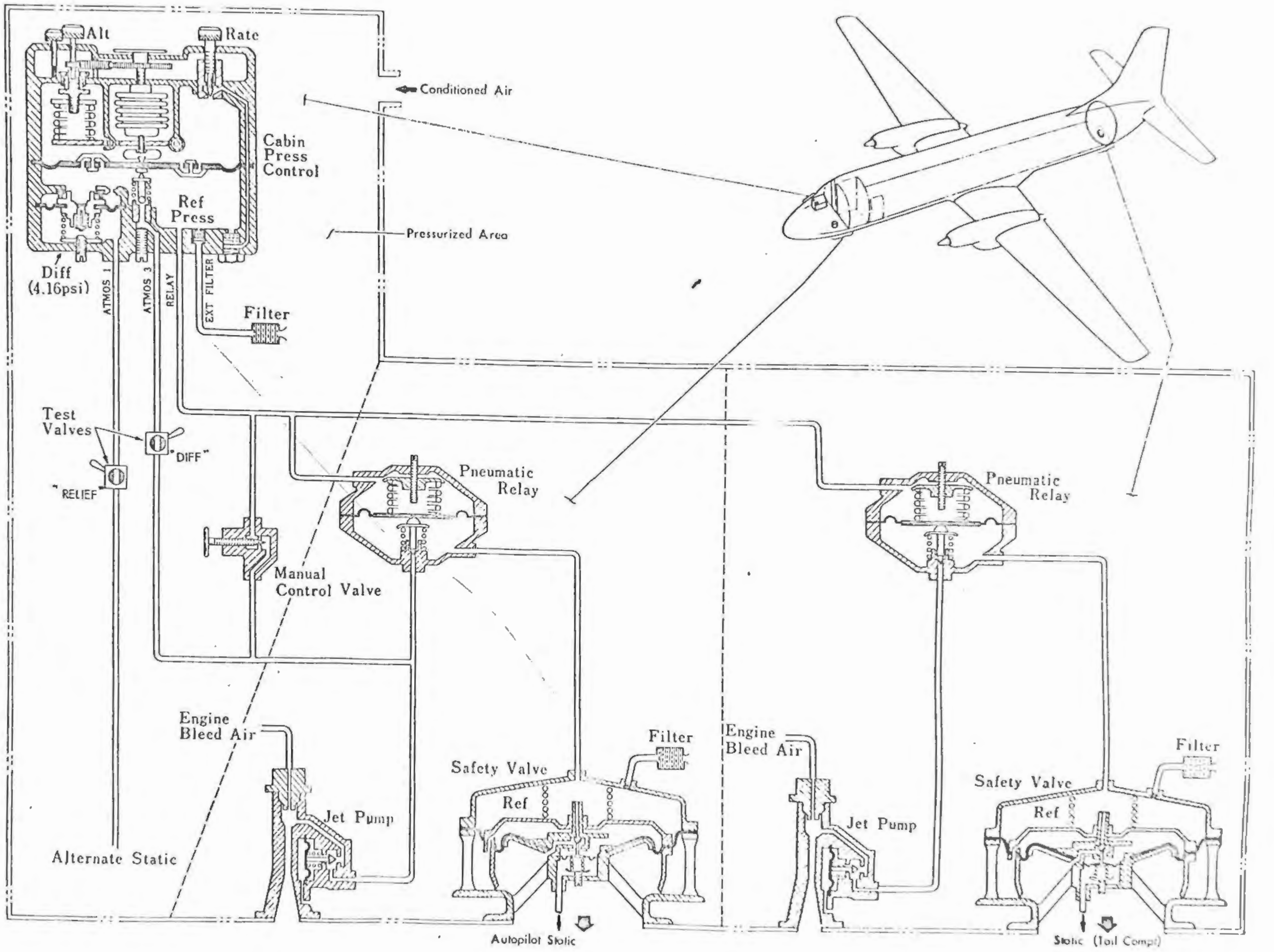
(5) Differential Pressure Mechanism

The higher the flight altitude, the less the atmospheric pressure and the greater the differential pressure. This is not desirable from the standpoint of airframe strength. If, therefore, the differential pressure exceeds the safe range, the differential pressure diaphragm of the differential pressure mechanism of the control is actuated, which relieving the reference pressure from the "ATMOS 1" to the static line regardless of the cabin altitude setting.

This function comes into action when the difference between the cabin pressure and the atmospheric pressure exceeds 4.16 psi. If the difference is reduced to less than 4.16 psi, it ceases to operate and returns to normal operation.

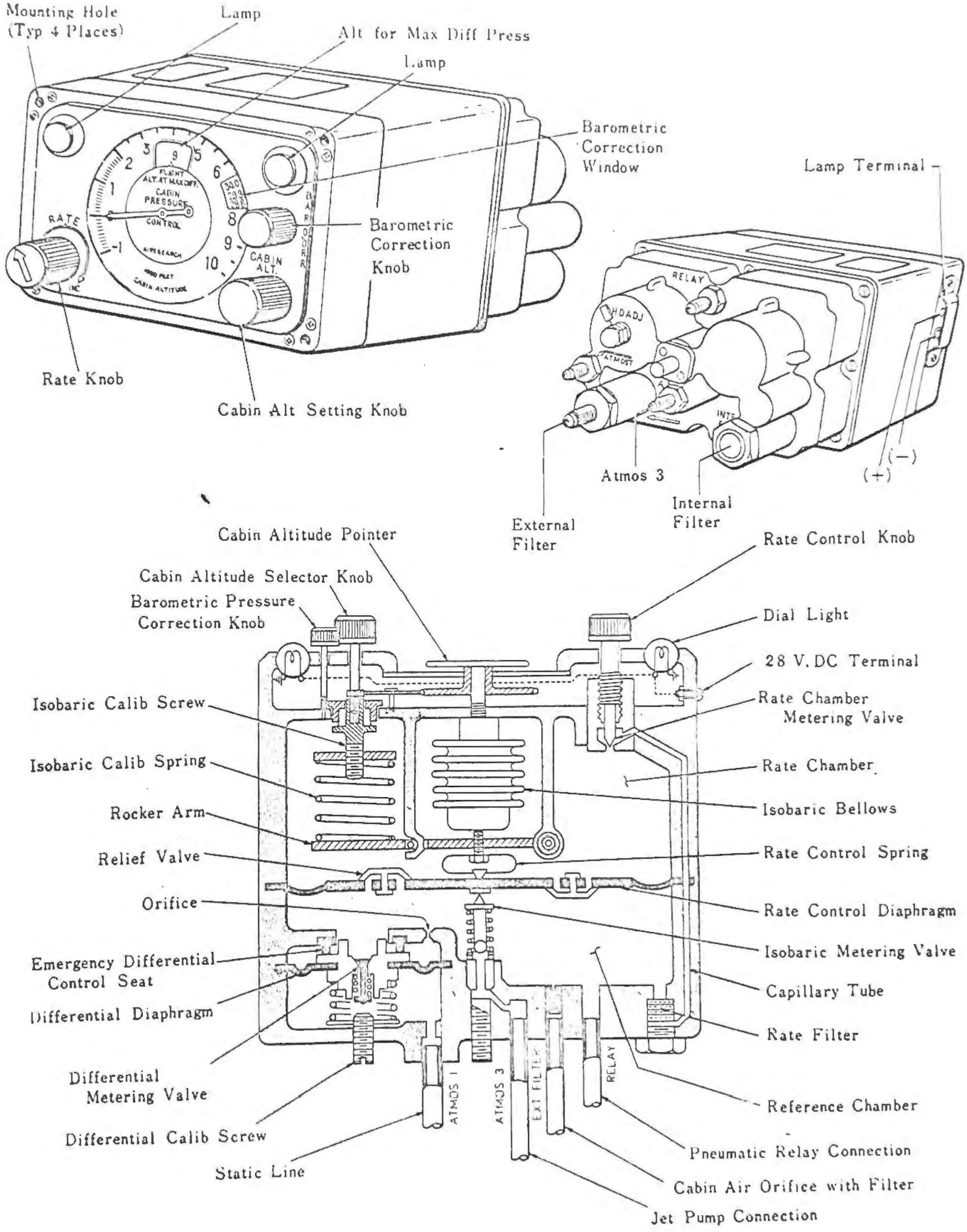
(6) Safety Valve Mechanism

The safety valve mechanism is self-contained in the outflow valve. If the difference between the cabin pressure and the static pressure exceeds 4.41±0.1 psi, a small diaphragm to which a ball type valve is connected is forced down, relieving the reference pressure, and opening the outflow valve.



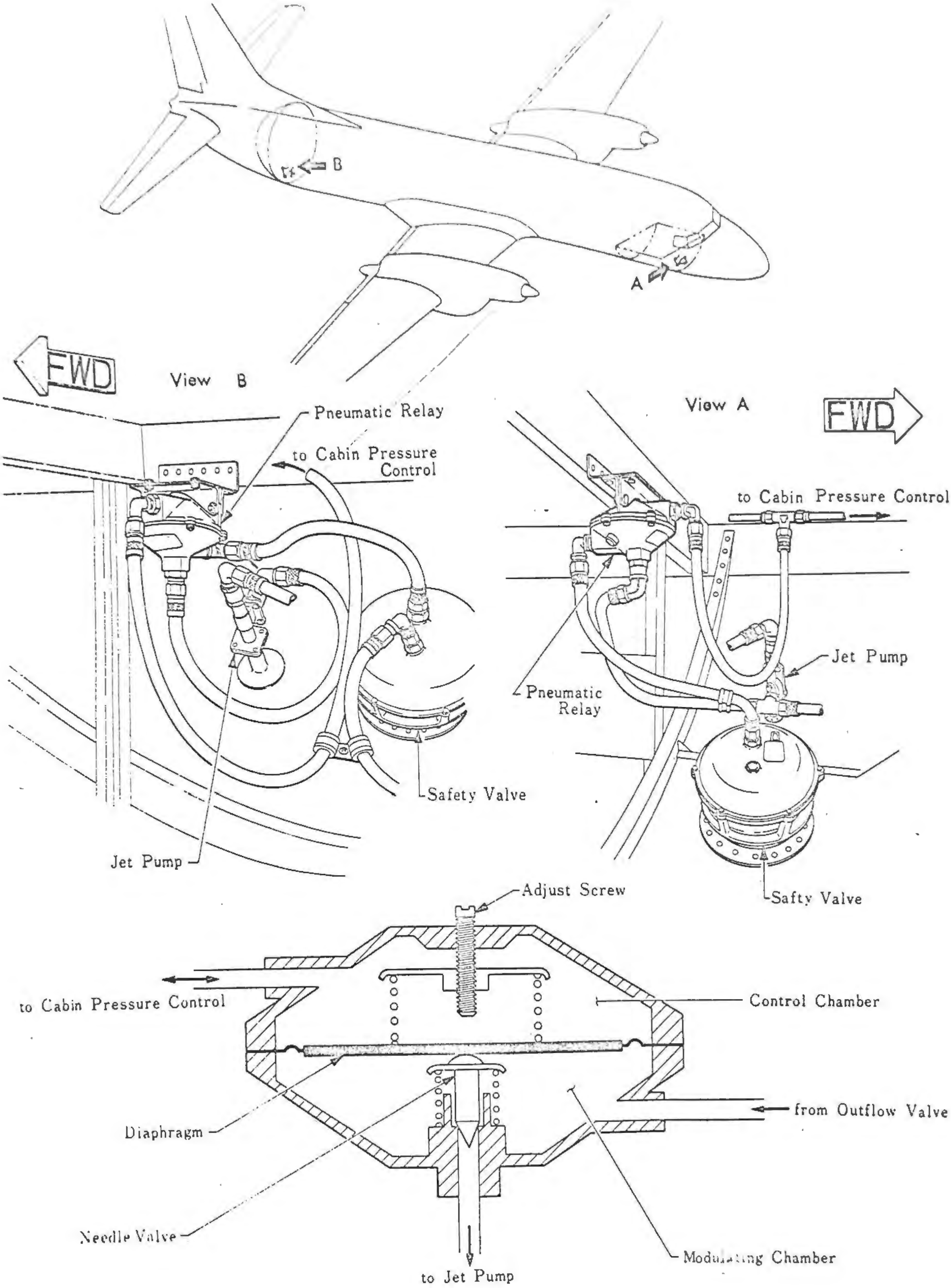
Cabin Pressurization System Schematic

Figure 12-26



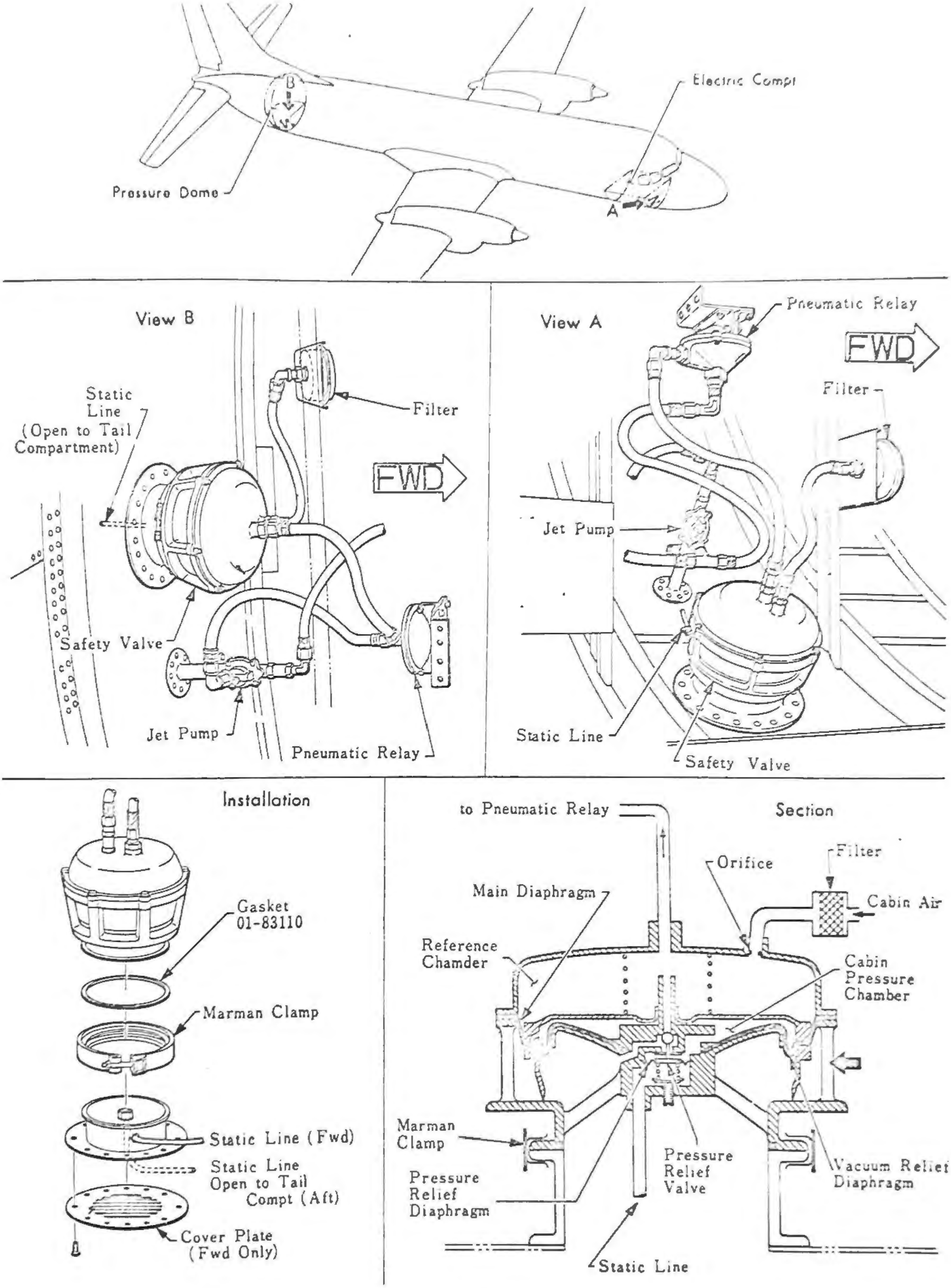
Cabin Pressure Control

Figure 12-27



Pneumatic Relay

Figure 12-28



Cabin Air Safety Valve

Figure 12-29

12.4.4 Automatic Pressure Control System

(1) Fixed Altitude Pressurizing Operation

Since the maximum differential pressure is 4.16 psi, the pressurizing capacity that can be practically utilized, consists of the following two:

a. Max. Pressurizing Schedule

If the pressure controller is set to the sea level (0 ft) before take-off, the cabin altitude is maintained at the sea level until the aircraft altitude reaches 8,900 ft. If the altitudes further increases, switchover is made to the fixed differential pressure operation.

b. Min. Pressurizing Schedule

If the pressure controller is set to 8,000 ft before take-off, the cabin altitude increases with the aircraft altitude up to 8,000 ft. When the aircraft altitude is between 8,000 ft and 20,000 ft, the cabin altitude can be maintained at 8,000 ft. If the aircraft altitude exceeds 20,000 ft, switchover is made to the fixed differential pressure operation.

Between the max. pressurizing schedule line and the min. pressurizing schedule line, therefore, the cabin altitude is maintained constant regardless of the aircraft altitude change.

(2) Fixed Differential Pressurizing Operation

This operation is performed irrespective of the pressure controller setting. If the aircraft altitude exceeds 8,900 ft under the max. pressurizing schedule or 20,000 ft under the min. pressurizing schedule, the cabin altitude begins to rise with a pressure altitude 4.16±0.1 psi higher than the aircraft altitude.

(3) Fixed Rate of Change Operation

By the rate control knob of the pressure controller, the rate of change of cabin pressure can be set between 50 ft/min and 2,000 ft/min regardless of the rate of change of the aircraft.

Under max. pressuring schedule, however, the cabin rate of climb, after the aircraft altitude has exceeded 8,900 ft, is switched to the fixed differential pressurizing operation regardless of the rate control setting. As a result, it climbs, keeping a max. differential pressure of 4.16 psi against the aircraft altitude.

12.4.5 Manual Pressure Control System

This is an auxiliary control system to be used when the automatic control is out of order. Its operation, therefore, should preferably be limited to the shortest possible period.

This control system controls the outflow valve by regulating the opening of the needle type manual pressure valve.
When the automatic control is in operation, therefore, this valve must always be kept in fully closed "INC" position.

When the cabin altitude setting is changed through manual control, it must be done carefully, while watching the cabin altimeter carefully.

In this case, neither the 4.16 psi differential pressure mechanism nor the rate control mechanism does not work, necessitating the manual control, while watching carefully the differential pressure indicator and the rate of climb indicator as well.

12.4.6 Cabin Pressure Relief System

For pressure relief, a pressure relief mechanism is self-contained in the outflow valve. This functions as a safety valve. Regardless of the pressure controller setting, therefore, if the differential pressure exceeds the following limit, pressure is relieved.

(1) Positive Pressure Relief

If the differential pressure exceeds 4.16±0.1 psi due to failure of the fixed differential pressure control mechanism, the cabin pressure must be relieved through the outflow valve so that the maximum differential pressure determined to protect the airframe construction will not exceed 4.41±0.1 psi.

(2) Suction Relief

If the atmospheric pressure becomes higher than the cabin pressure, it presses the airframe from outside. To protect the airframe construction, therefore, if the atmospheric pressure becomes 0.2 psi higher than the cabin pressure, the vacuum relief diaphragm is actuated, introducing the external air into the cabin from the outflow valve, thus keeping balance.

Furthermore, when the aircraft is on the ground, the cabin can be maintained in non-pressurized condition by the function of a jet pump.

12.4.7 Test Valve System

When the aircraft is on the ground, no sufficient differential pressure to operate the fixed differential pressure mechanism (4.16 psi) can be obtained, even if the normal maximum pressure (-1,000 ft) is applied.

Furthermore, if the system is in normal operation, the maximum differential pressure of 4.41 psi cannot be obtained, whether the aircraft is on the ground or in the air.

To accomplish the function test for these relief mechanisms on the ground, therefore, the respective test valves are provided on the copilot side console. Under normal condition, these valves are kept in the "NORM" or "opened" position, locked with a stopper.

(1) "DIFF" Test Valve

If this is placed in "TEST" position where the valve is closed, the pressure of the reference chamber of the pressure controller is reduced to zero through suction by the jet pump.
As a result, the chamber pressure rises and becomes 4.16 psi higher than the ground pressure. Accordingly, the fixed differential pressure mechanism of the pressure controller is actuated.

(2) "RELIEF" Test Valve

This valve is used to test the relief mechanism with the structurally established maximum differential pressure of 4.41 psi. With the "DIFF" valve in closed position, if this valve is also closed in "TEST" position, the static port of the pressure controller is closed so that the fixed differential pressure mechanism ceases to operate. Thus the difference between the pressure of the reference chamber (equivalent to the cabin pressure) and the atmospheric pressure exceeds 4.16 psi and reaches 4.41 psi.

As a result, the relief mechanism of the safety valve is actuated, relieving the cabin pressure.

12.4.8 Indicators and Warning Lights

The indicators include a cabin altimeter, a cabin rate of climb indicator and a cabin differential pressure indicator.

The warning lights include a cabin differential pressure warning light and a cabin altitude warning light.

(1) Cabin Altimeter

The same type of altimeter as that provided on the flight instrument panel is located on the copilot side console to indicate the pressure altitude of the cabin.

The difference between the flight and cabin altimeters is that while the sensing port of the flight altimeter is coupled with the static port of the airframe, that of the cabin altimeter is open in the cabin to find the cabin pressure.

(2) Cabin Rate of Climb Indicator

As in the case of the cabin altimeter, this is also the same type of rate of climb indicator as that provided on the flight instrument panel. Its static port is open to the cabin pressure so that the rate of climb of the cabin pressure can be read.

(3) Cabin Differential Pressure Indicator

This indicates the difference between the cabin pressure and the altitude pressure of the airframe, that is, the degree of pressurization. Its pressure port is open to the cabin pressure, while its static port is connected to the static selector of the copilot.

(4) Cabin Differential Pressure Warning Light

It is a "red" light located on the copilot side console.
If the cabin differential pressure exceeds 4.5±0.25 psi, the pressure switch is closed, lighting the lamp and sounding the buzzer.

The sensing port of the pressure switch is connected to the cabin pressure and the copilot side static port.

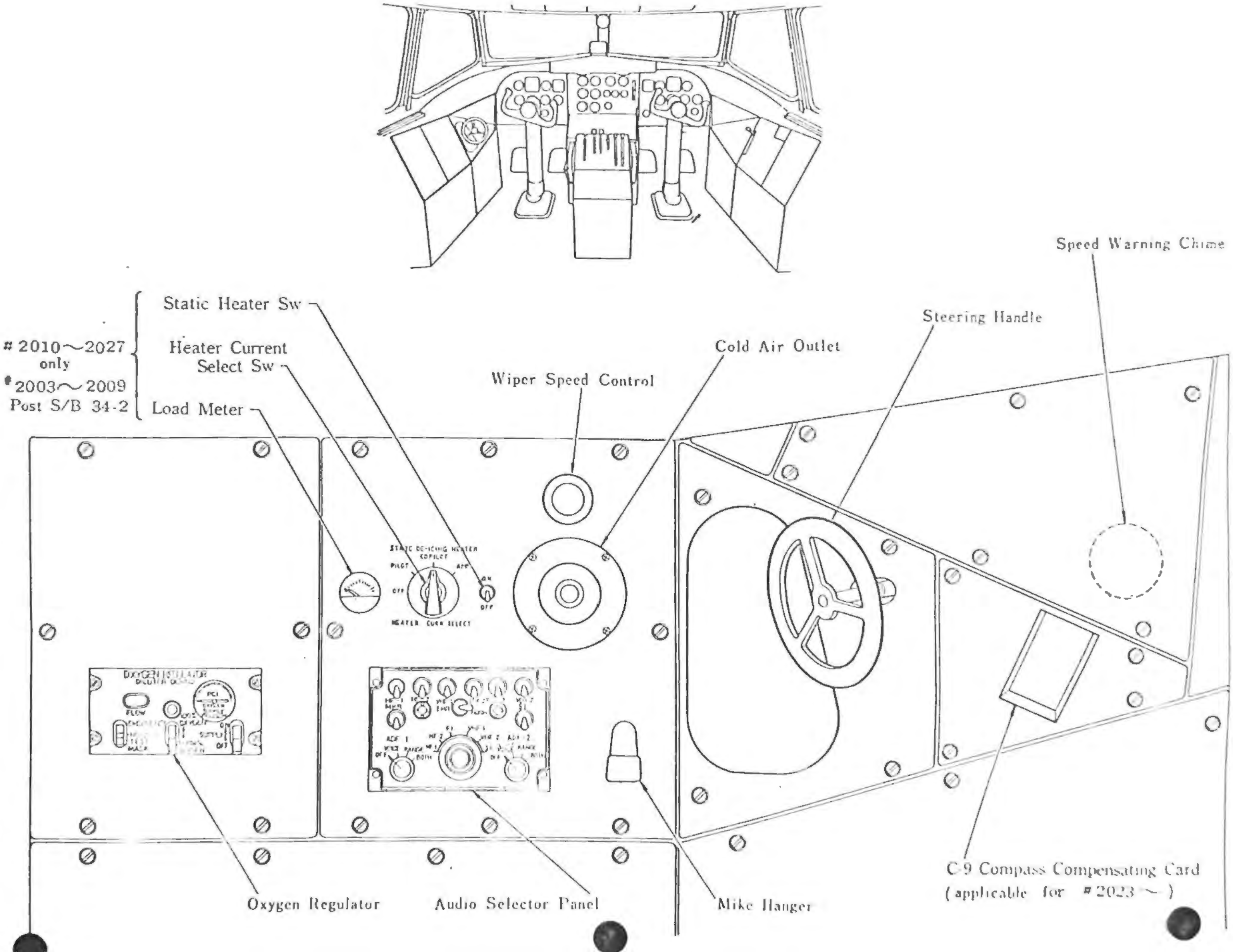
The buzzer is common to this air conditioning system and other warning systems and can be cut off by depressing the buzzer cut button on the overhead panel.

(5) Cabin Altitude Warning Light

It is a "red" light located on the copilot side console. If the cabin altitude exceeds 10,000±300 ft, the light comes on by the function of the pressure switch located inside the rear of the side console.

The pressure switch is open to the cabin pressure. The bellows inside the pressure switch are always kept in compressed condition, held down by the cabin pressure from the sensing port. If, however, the cabin pressure exceeds 10,000±300 ft, the bellows are expanded and the switch contacts are closed lighting the lamp and sounding the buzzer.

This electrical circuit has a timer so that the light and buzzer are alternately turned on and off at an interval of one second.



LH Side Panel
Figure 12-30

Pitch Stops & Safety Features

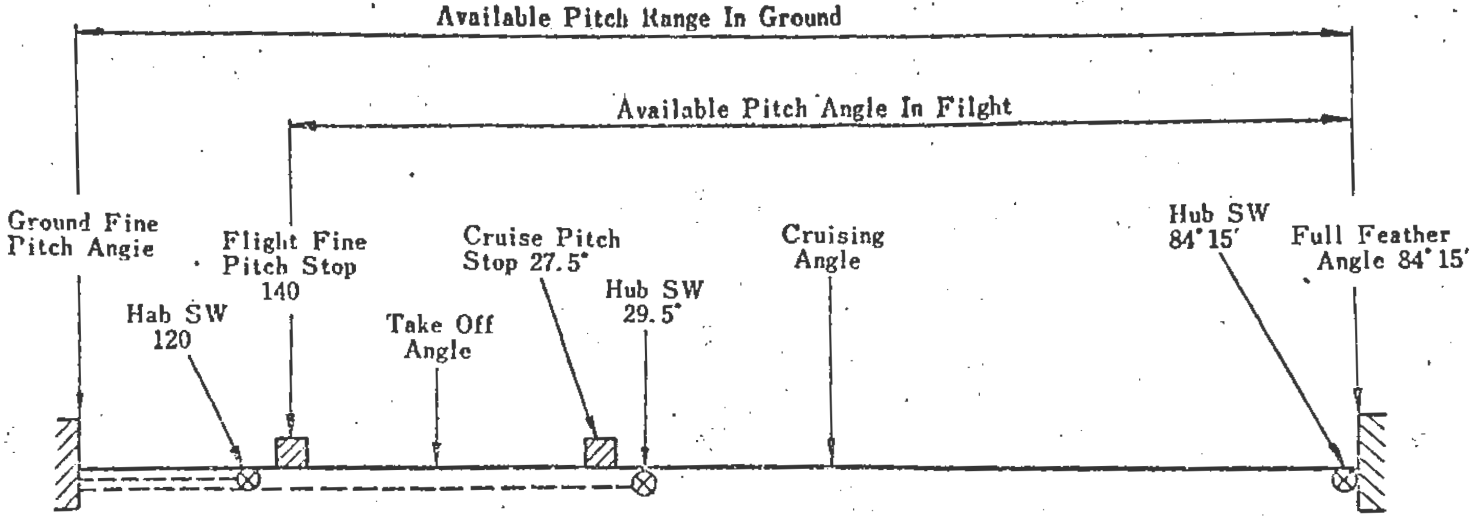
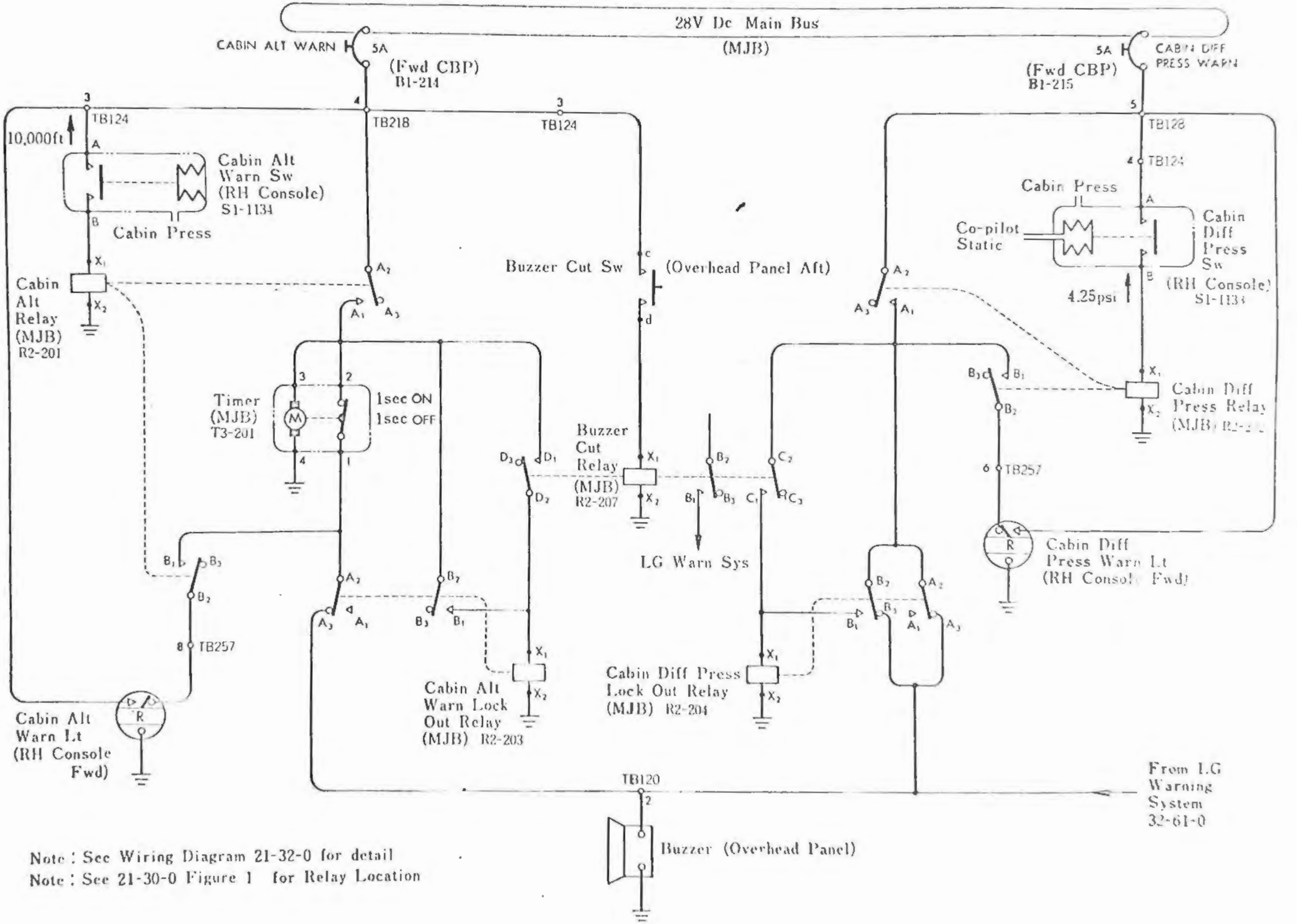

Available Pitch Range In Ground
Available Pitch Angle In Filght
Ground Fine Pitch Angie
Flight Fine Pitch Stop 140
Hab SW 120
Take Off Angle
Cruise Pitch Stop 27.5°
Hub SW 29.5°
Cruising Angle
Hub SW 84° 15′
Full Feather Angle 84° 15′

Fig 5 – 11


28V Dc Main Bus
(MJB)
CABIN ALT WARN
5A
(Fwd CBP)
B1-214
5A
CABIN DIFF PRESS WARN
(Fwd CBP)
B1-215
TB124
TB218
TB124
TB128
TB124
10,000ft
Cabin Alt Warn Sw (RH Console) S1-1134
Cabin Press
Cabin Alt Relay (MJB) R2-201
Timer (MJB) T3-201
1sec ON
1sec OFF
Buzzer Cut Sw
(Overhead Panel Aft)
Buzzer Cut Relay (MJB) R2-207
LG Warn Sys
Cabin Press
Co-pilot Static
Cabin Diff Press Sw
(RH Console)
S1-1134
4.25psi
Cabin Diff Press Relay (MJB) R2-202
TB257
Cabin Diff Press Warn Lt (RH Console Fwd)
TB257
Cabin Alt Warn Lt (RH Console Fwd)
Cabin Alt Warn Lock Out Relay (MJB) R2-203
Cabin Diff Press Lock Out Relay (MJB) R2-204
TB120
Buzzer (Overhead Panel)
From LG Warning System 32-61-0

Note : See Wiring Diagram 21-32-0 for detail

Note : See 21-30-0 Figure 1 for Relay Location

Cabin Pressure Warning System Schematic

Figure 12-31

12.5 Temperature Control System

12.5.1 System Operation

This system permits the independent control of cabin and cockpit temperatures by the control panel of the galley and the temperature selector located on the copilot side panel respectively.

For temperature control, the conditioned air of a desired temperature is produced by properly changing the mixing ratio of hot air directly taken from the supercharger outlet and cold air taken from the cooling system.

This mixing ratio is changed by adjusting the amount of hot air through controlling the opening of the mixing valves located in the respective hot air ducts of the cabin and cockpit.

If the mixing valve is fully opened and the temperature still low, the opening of the back pressure valve located at the outlet of the supercharger and the anti-ice valve which by-passes the cooling turbine secondary heat exchanger, is adjusted to obtain a room temperature of approx. 27 to 28°C (65° to 80°F).

In other words, the conditioned air of a desired temperature is obtained by controlling the four electrically-driven (D.C) valves.

The system mainly accomplishes the following functions:

(1) Temperature selecting

(2) Temperature sensing

(3) Valve mechanism and control

If a certain temperature is selected by the temperature selecting function, the temperature and the present room temperature sensed by the temperature sensing function are led to the valve control function, detecting the difference between them, and controlling the valve opening in such a way that the difference will be reduced to zero. In this manner, the room temperature is controlled to the selected temperature.

As described above, this system is designed for fully electrical operation. The selected and sensed temperature are converted into the resistance values of the electrical bridge circuit in the temperature controller. Current continues to flow until the bridge circuit is balanced.

This current is amplified by a magnetic amplifier located in the same controller to obtain sufficient electric power to actuate the valve mechanism and operate the respective valves.

12.5.2 Main Components

Part Name	Location	EA/SHIP
Auto-Manual Select SW	Cockpit, Galley	2
Temperature Selector	"	2
Temperature Control	Elect. Compt.	2
Temperature Sensor	Cockpit, Galley	2
Temperature Anticipator	Air-Con. Compt.	2
Cabin Air Mixing Valve	Air-Con. Compt.	1
Cockpit Air Mixing Valve	"	1
Cooling Turbine Anti-Ice Valve	"	1
C/S Back Pressure Valve	"	1
Ram Air Valve	"	1

(1) Temperature Control

This is located in the electrical compartment. The front side (this side) is the cabin temperature controller, while the rear side is the cockpit temperature controller. Note that they are not interchangeable.

The controller power supply is AC 400c/s 115V but DC (half wave) goes to the bridge circuit and rectified and smoothed full wave DC 28V to the valve drive circuit. The interior is a combination of a magnetic amplifier and a silicon controlled diode.

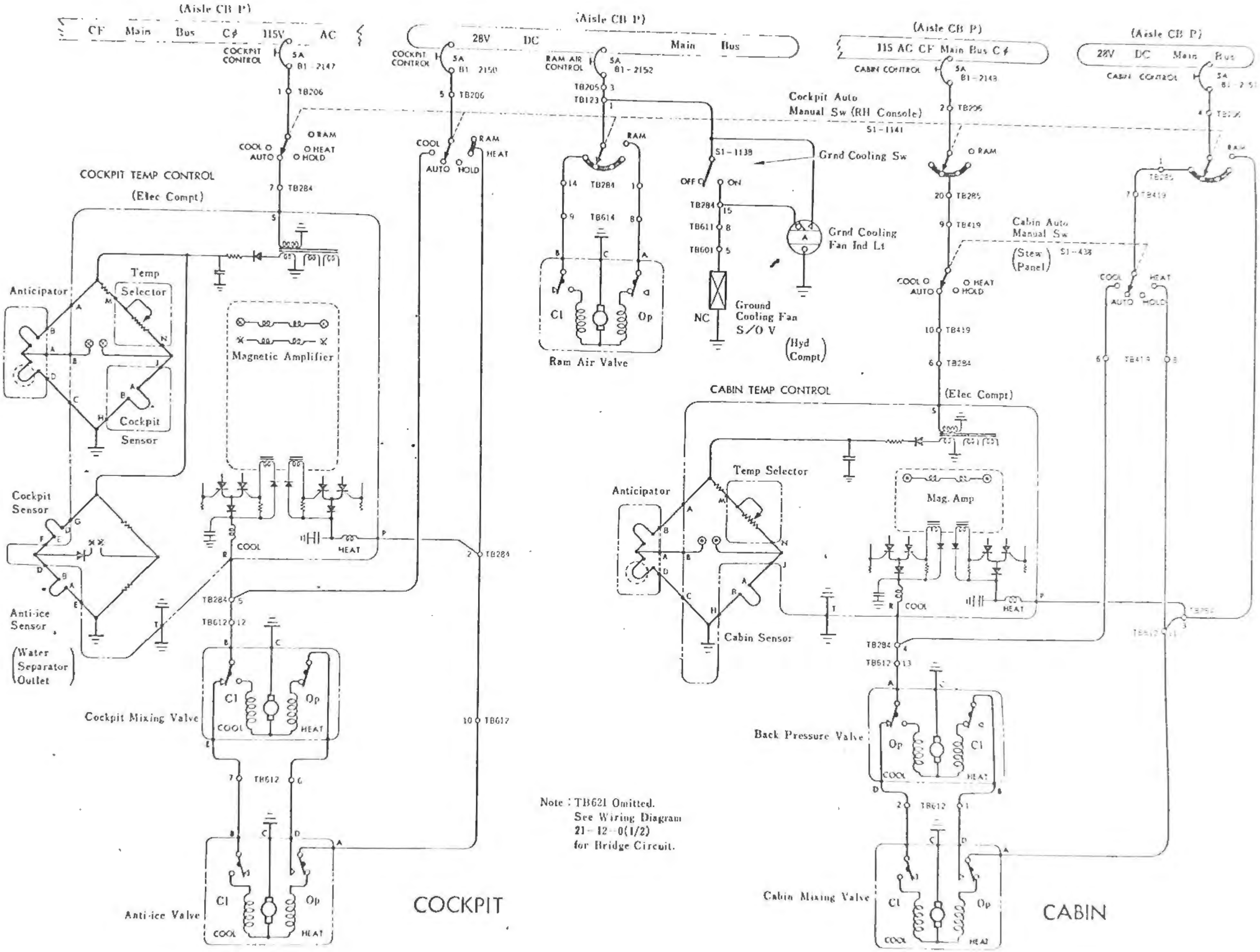
(2) Valves

All the butterfly valves are operated by a DC 28V reversible motor. The back pressure valve alone is much larger than the other four and is of partially closed type which has a gap of 2.9 sp.in. in fully closed position.

Their interchangeability is as follows:

Cockpit mixing valve ⟷ Anti-ice valve
Cabin mixing valve ⟷ Ram air valve

The mixing valves are not interchangeable. Furthermore, their locations are close to each other so that care should be taken not to mistake one for the other. Pay attention to the duct routing.



Temperature Control Electric System Schematic

Figure 12-32

12.5.3 Temperature Control

(1) Automatic Temperature Control

Place the auto-manual selector switch in the "AUTO" position and set the temperature selector to a desired position, and the valves are controlled by the temperature controller until the temperature is adjusted to the selected temperature.

(2) Manual Temperature Control

If trouble occurs in the temperature controller, set the auto-manual selector switch to "OFF", and the circuit which leads to the temperature controller is cut off and the valve mechanism maintains the opening at that time.

To raise or lower the present room temperature, rotate the temperature selector to "Heat" or "Cool". By so doing, the valve is opened or closed during the time the selector is kept at the position.

In this case, DC power is directly applied to the valve through the switch. If the switch is left at that position, the valve is fully opened or fully closed.

Approx. 15 to 25 secs is required before the valve is fully opened or closed. Furthermore, there is a considerable time lag between the action of the valve and the introduction of the conditioned air corresponding to the temperature change into the cabin. For controlling the temperature, therefore, it is necessary to consider these points as well. As a result, it is difficult to set the room temperature at a proper temperature.

For this reason, manual control should be regarded as supplementary means to automatic control and should be limited to the shortest possible period.

12.5.4 Temperature Selecting

This is simply a variable resistor (1.2KΩ±5%) which constitutes one side of the DC circuit for the temperature controller. Therefore, setting its resistance value to a desired value means giving the instruction of a desired room temperature to the temperature controller.

12.5.5 Temperature Sensing

This function consists of two components, a temperature senser and a temperature anticipator. These respectively constitute the sides of the DC bridge circuit for the temperature controller.

(1) Temperature Sensor

Mounted on the bulkhead in the rear of the copilot seat and the bulkhead between the cabin and the galley in the rearmost part of pressure valve begins to close. The valve is placed in fully closed position where the valve opening corresponds to 2.19 sq.in.

b. Cool

For cooling, first the back pressure valve is fully opened. The air mixing valve then begins to close and finally closes fully.

(2) Cockpit

a. Heat

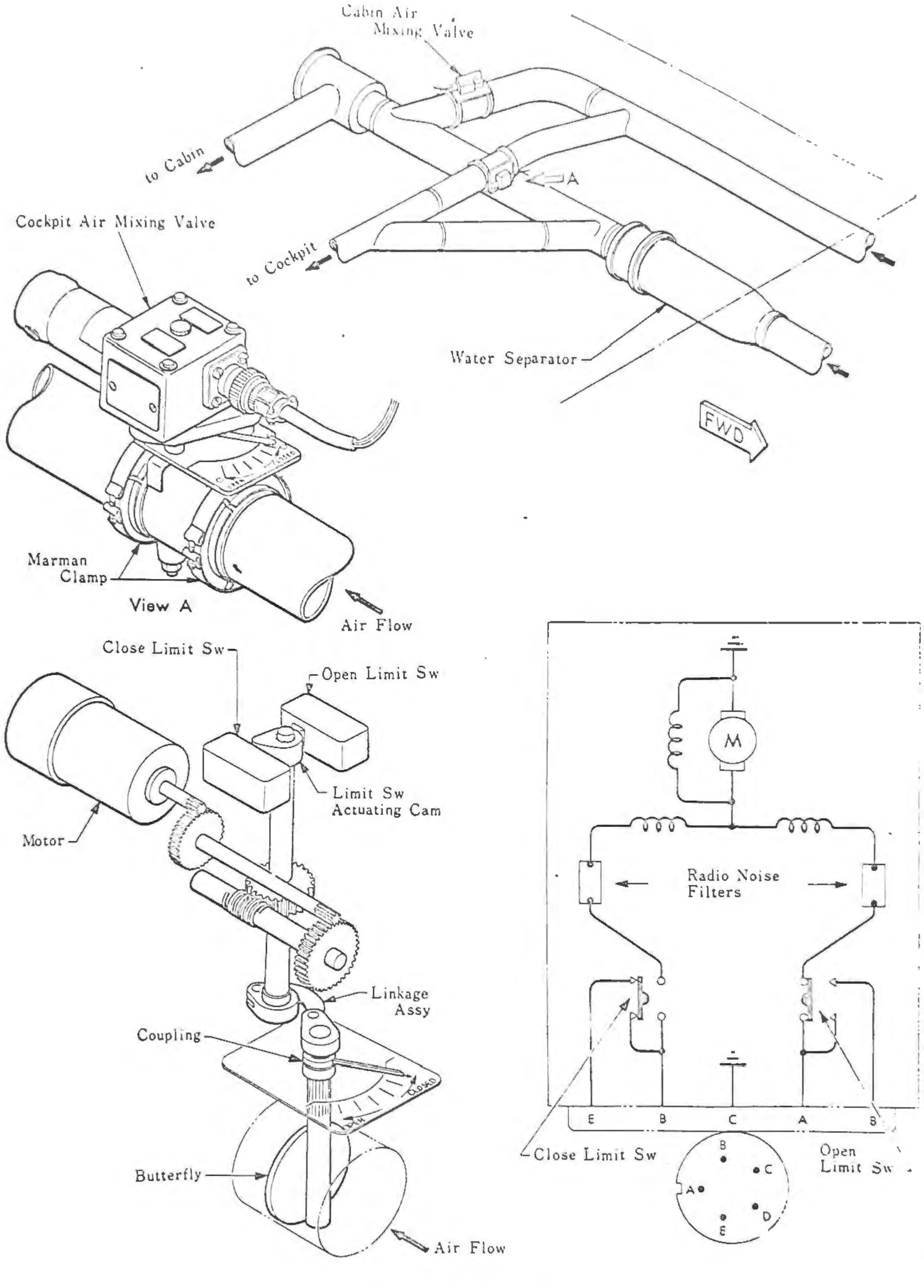
First, the anti-ice valve is fully opened. The air mixing valve then begins to open and finally opens fully.

b. Cool

First, the air mixing valve is fully closed. The anti-ice valve then begins to close and finally closes fully.

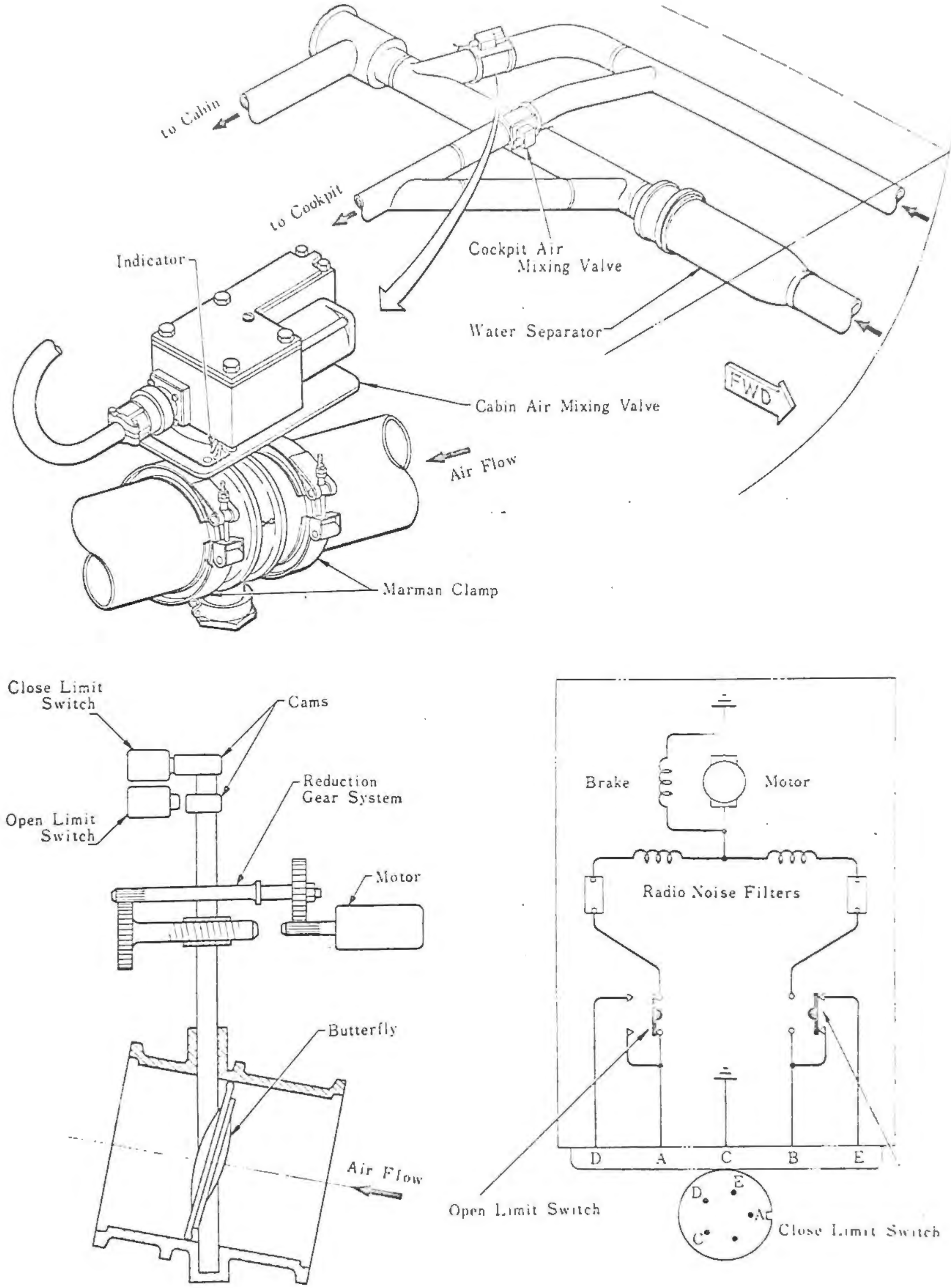
12.5.7 Ram Air Input

The cockpit auto-manual switch has a position marked "RAM". If the knob is set to this position, the ram air valve which leads ram air from the ram air inlet duct of the primary heat exchanger is opened which makes air conditioning impossible. In this case, ram air is led into the cabin so that the cabin and cockpit air mixing valves must be open. With the selector knobs of the cabin and cockpit at any positions, therefore, the air mixing valves are opened by an electrical circuit.



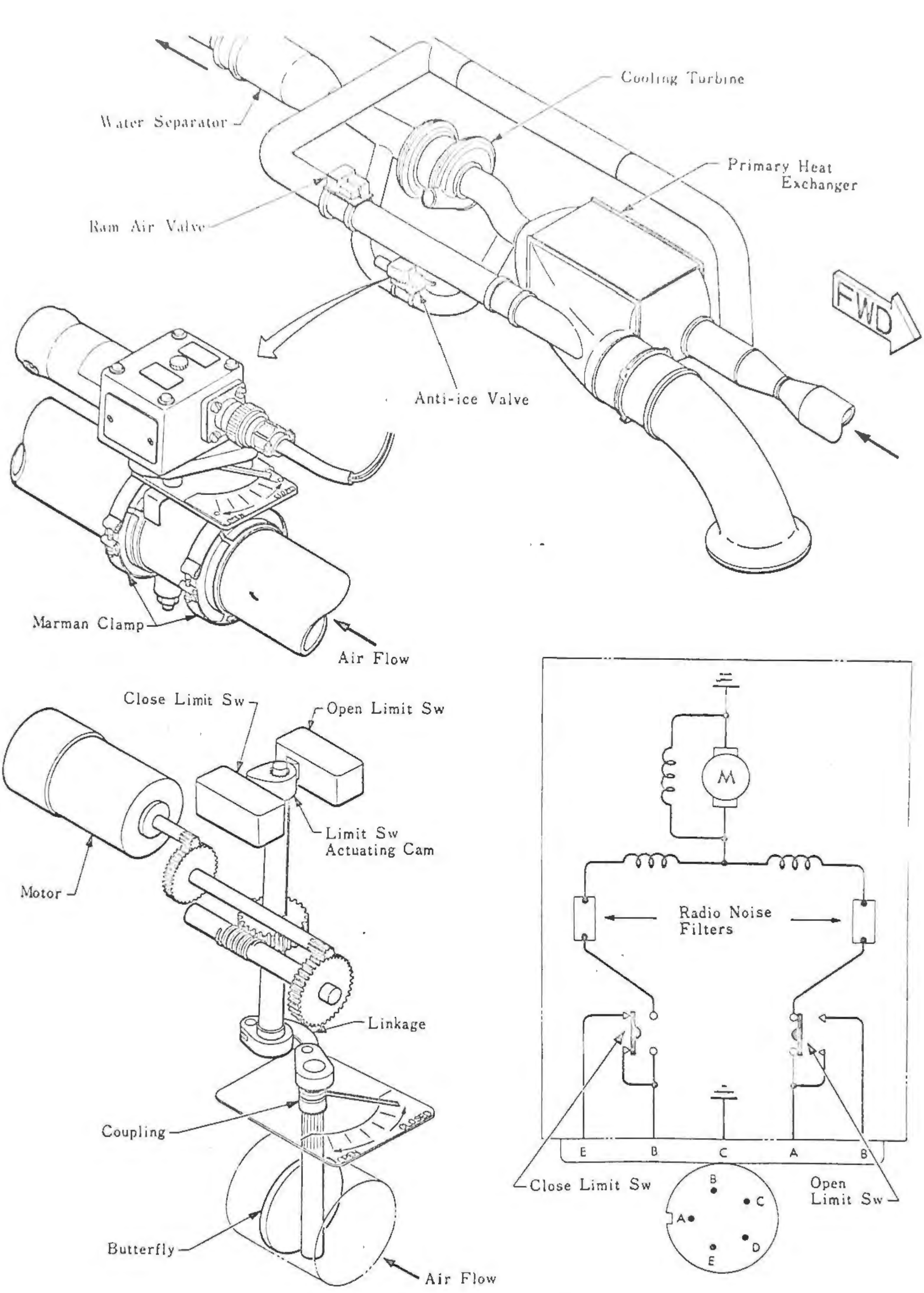
Cockpit Air Mixing Valve

Figure 12-33



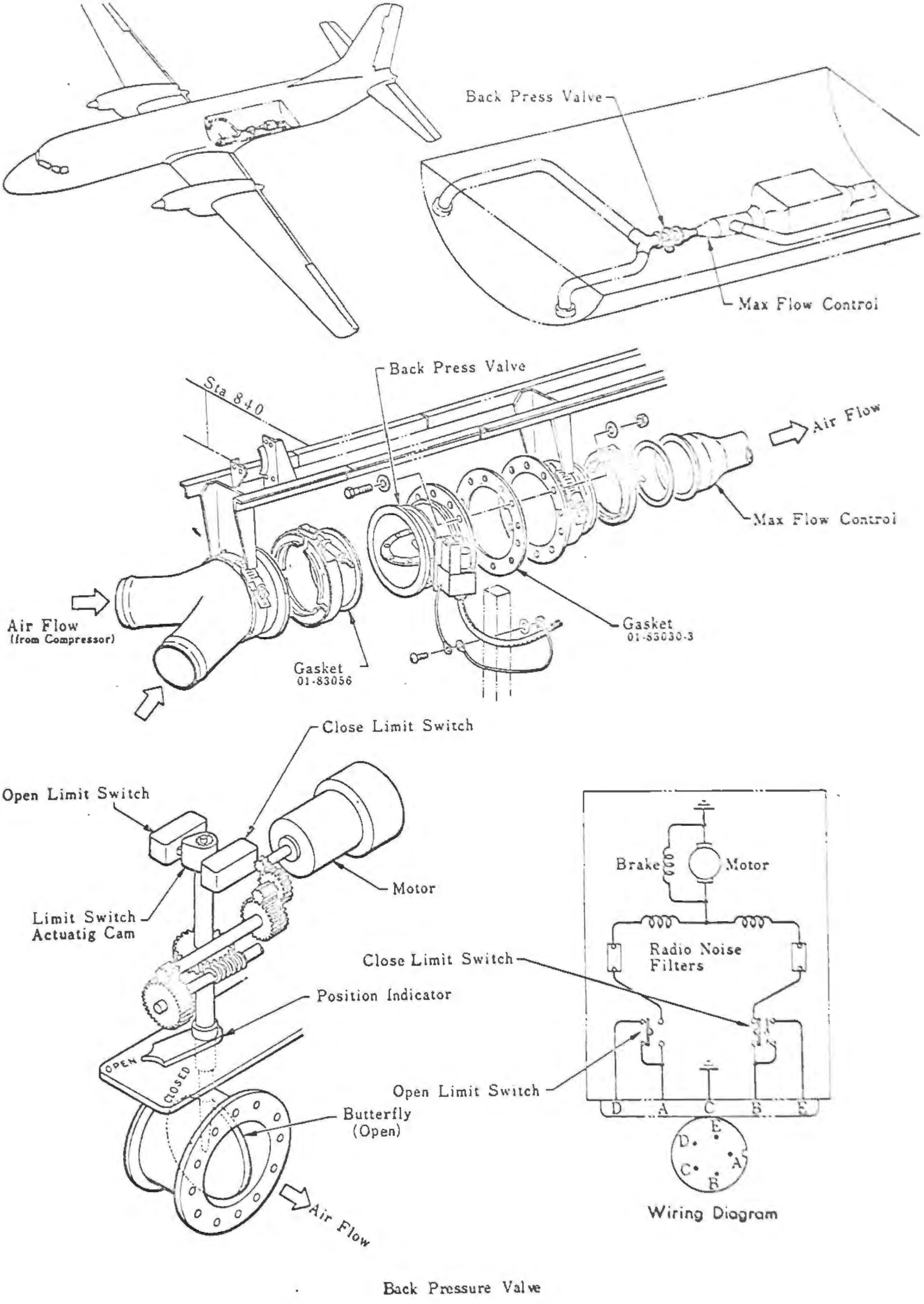
Cabin Air Mixing Valve

Figure 12-34



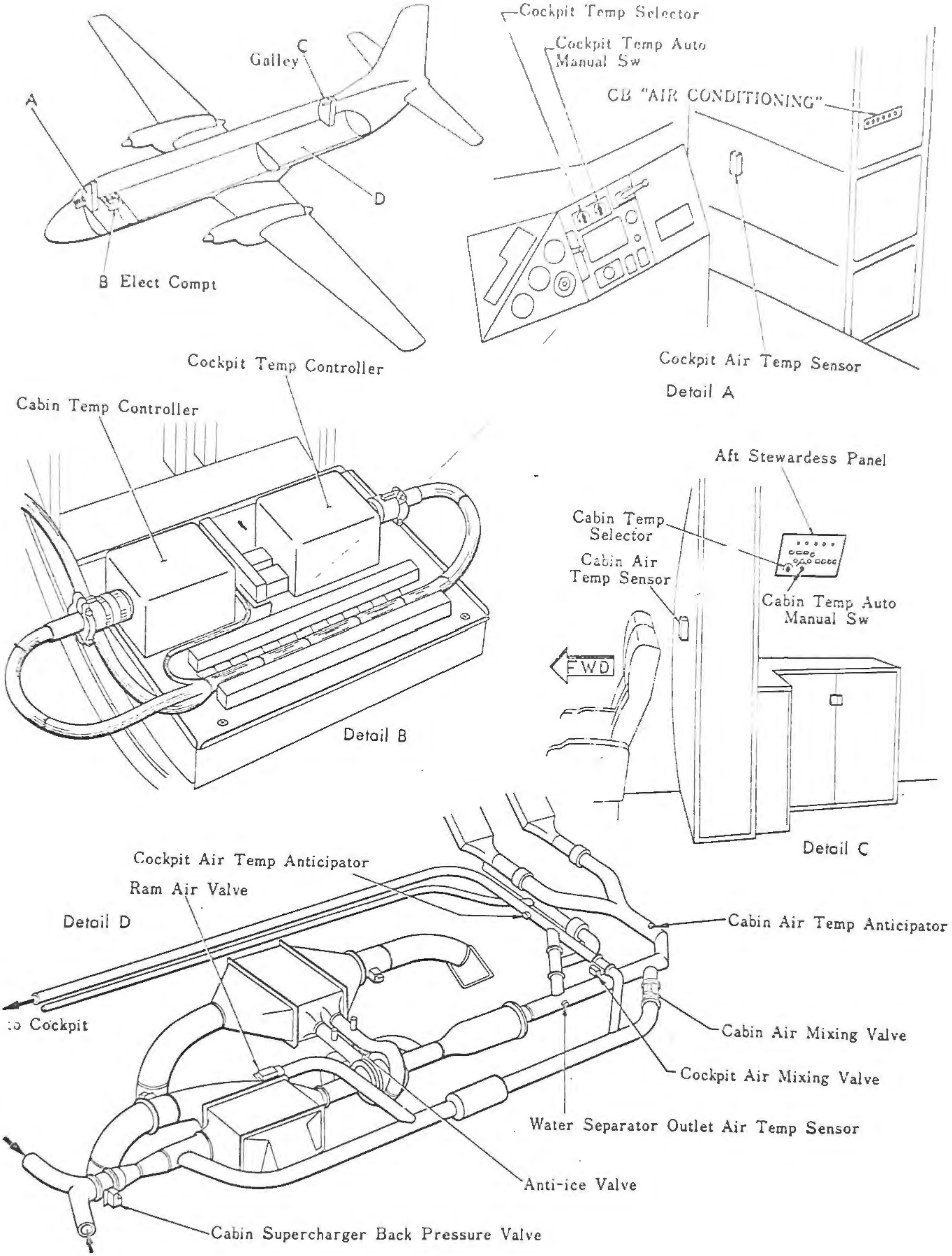
Cooling Turbine Anti-ice Valve

Figure 12-35



Back Pressure Valve

Figure 12-36



Temperature Control System Arrangement

Figure 12-37

NOTE: THIS APPLYS TO AIRCRAFT N187P, N189P, N214P AND N128P ONLY.

Foot Warmer Heater

GENERAL (See Figure 1 - 3)

The foot warmer (electric heater) is located in the conditioned air duct running forward beneath the R.H. floor of the cockpit.

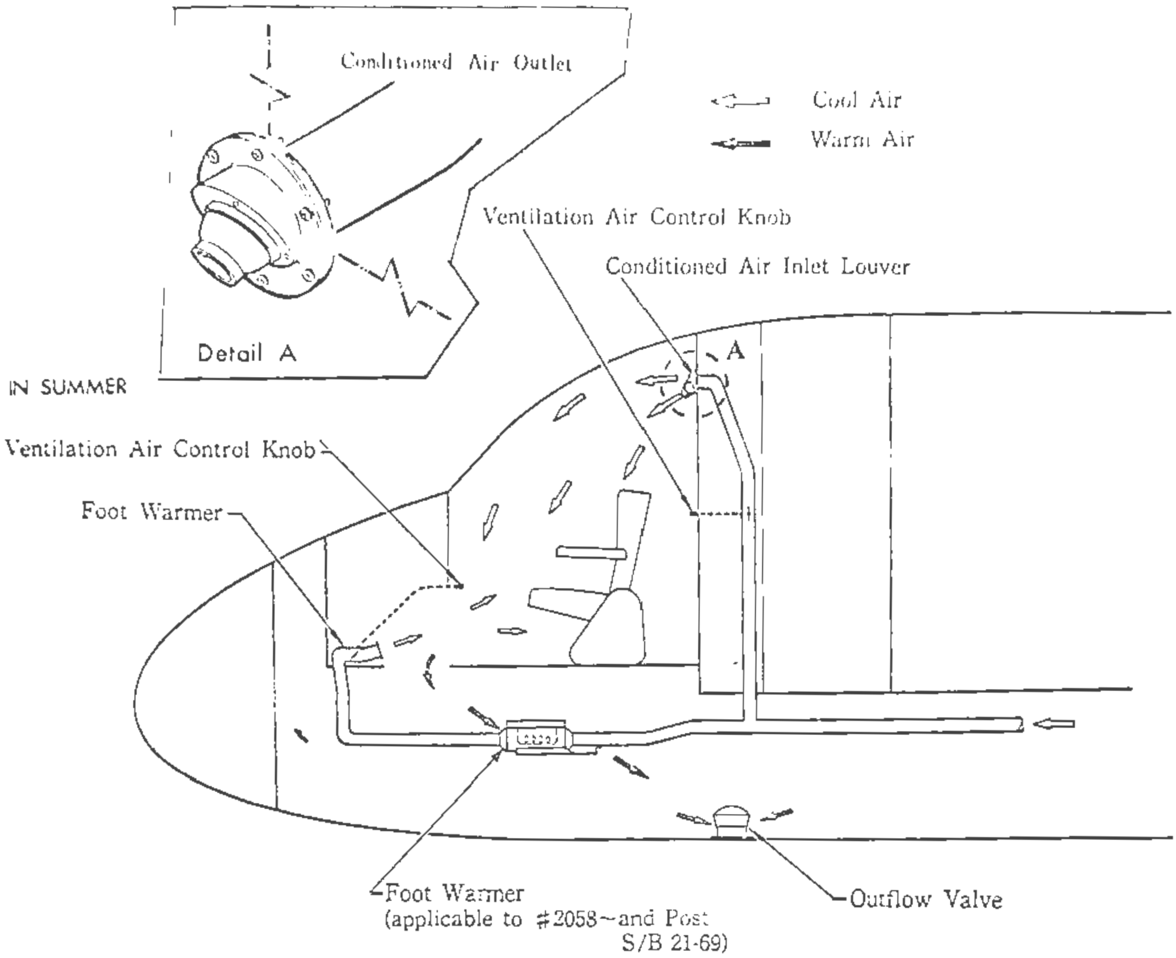
This foot warmer is operated by the foot warmer switch located on the R.H. Side Panel, reheating the conditioned air as necessary to warm the feet of pilots.

This heater is an electric heater with metallic tube heating elements (alumica heater), operating on 2KW wild frequency power supply. A cycling switch and overheat switch are provided so as to accomplish automatic "ON-OFF control" of temperature.

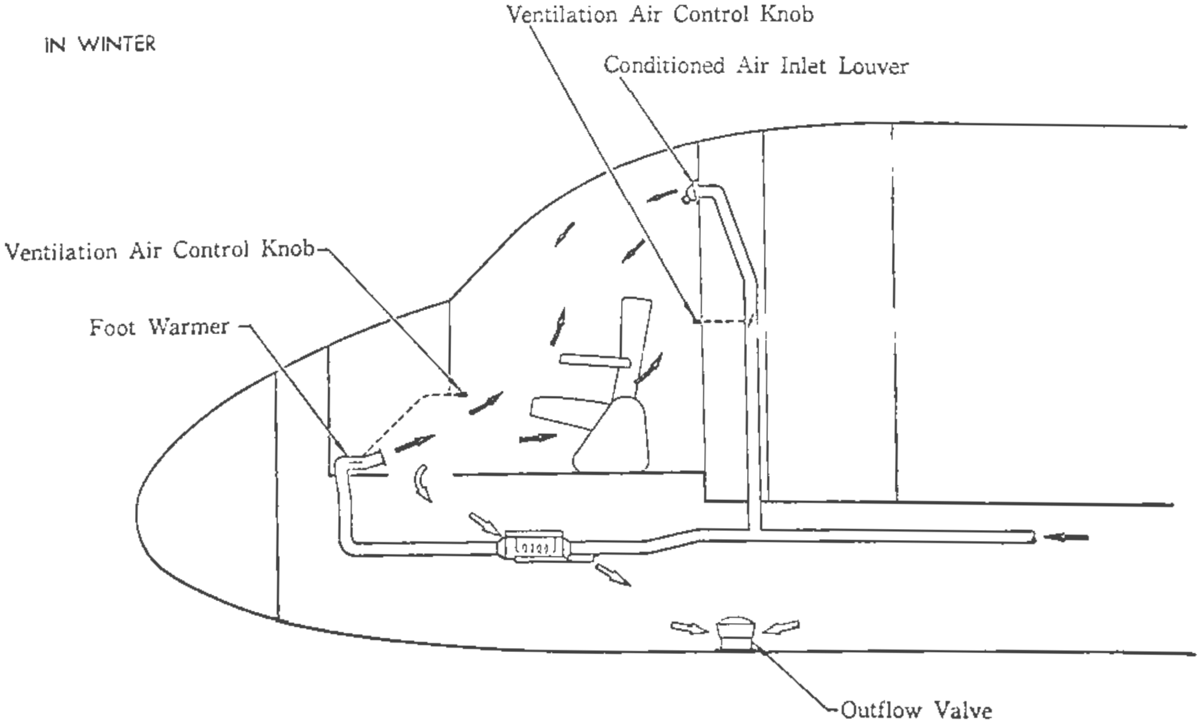
The setting temperatures for both switches are 250°F (125°C) but the locations are so selected that the working temperatures are different. 28W D.C. is supplied to the control circuit.

The temperature of the air delivered by the foot warmer varies according to the air flow but it is usually between 60°C and 120°C.

The heater body, made of stainless steel, is provided with an aluminum cover so as to protect the terminal plate. The entire unit is insulated from heat by glass wool and attached to the bracket on the fuselage with four screws.


IN SUMMER

Conditioned Air Outlet
Detail A
Cool Air
Warm Air
Ventilation Air Control Knob
Conditioned Air Inlet Louver
A
Ventilation Air Control Knob
Foot Warmer
Foot Warmer
(applicable to #2058~and Post
S/B 21-69)
Outflow Valve


IN WINTER

Ventilation Air Control Knob
Conditioned Air Inlet Louver
Ventilation Air Control Knob
Foot Warmer
Outflow Valve

Fig 1 Cockpit Air Distribution

NOTE: THIS APPLYS TO
AIRCRAFT N187P,
N189P, N214P AND
N128P ONLY.

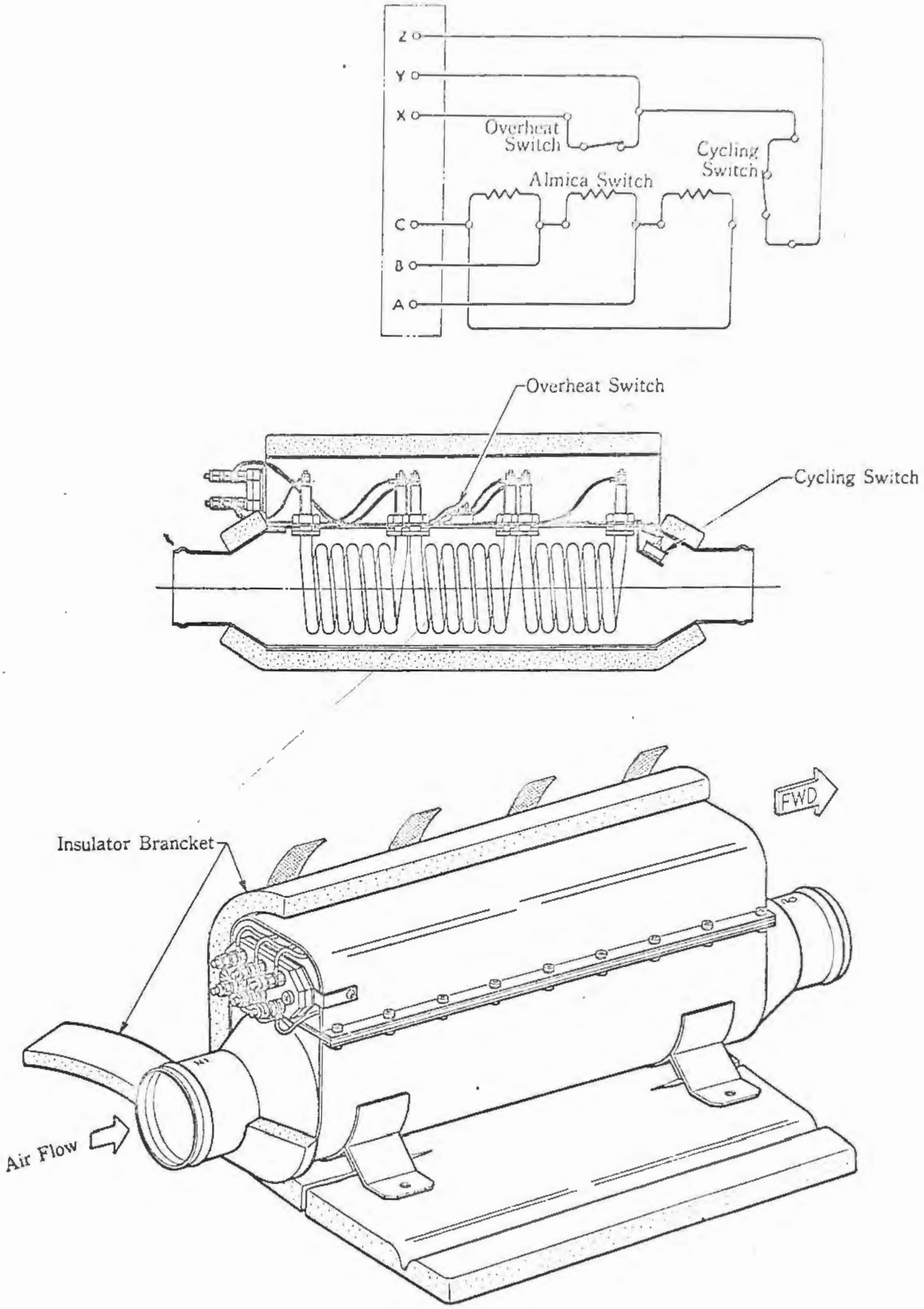
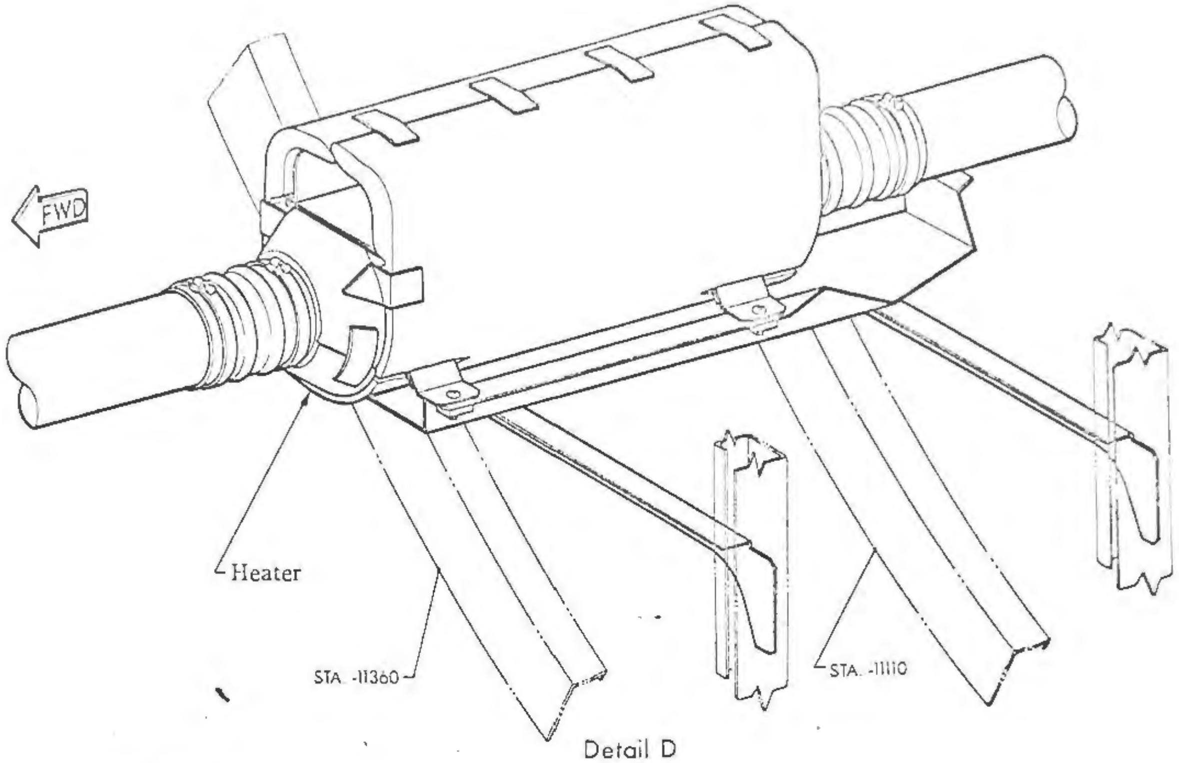
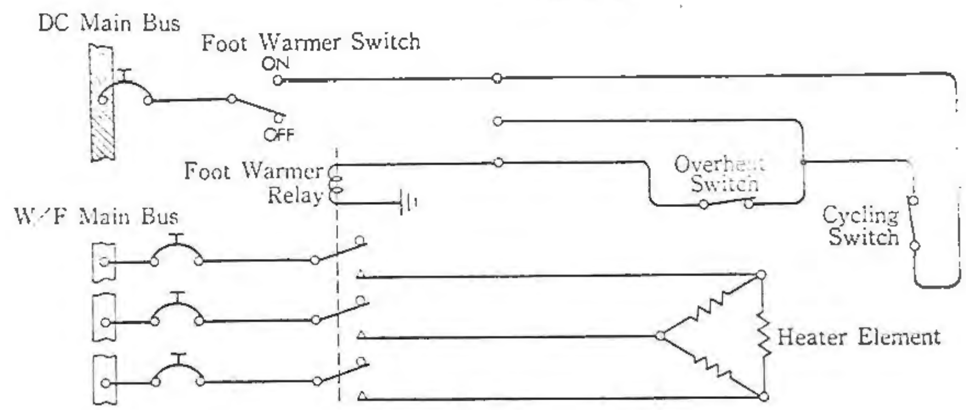
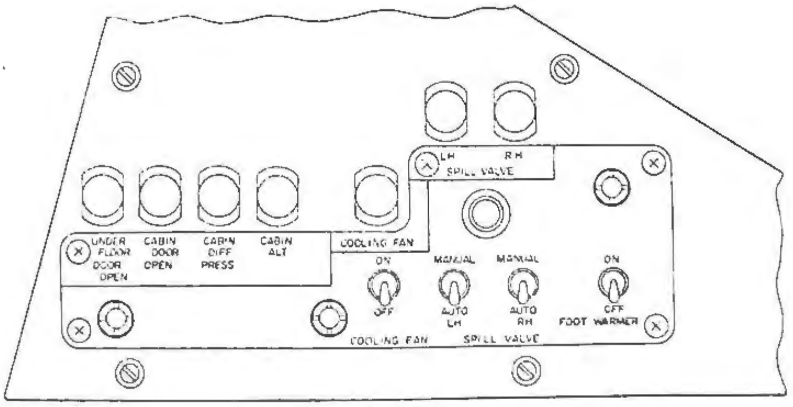


Fig 2 Foot Warmer



Detail D





Detail E

Fig 3 Foot Warmer

Chapter 13 ANTI-ICING & DEICER SYSTEM

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Chapter 13 ANTI-ICING & DEICER SYSTEM

13.1 General Description

13.1.1 Outline

The purpose of this system is to protect such important systems as wing, propeller, engine air intake scoop, pitot tube, and static port which are liable to icing due to impact with the atmospheric air during the flight by preventing or eliminating icing by means of electric heaters or rubber boots.

13.1.2 Classification of System

(1) Airfoil Anti-icing System

  a. Main wing deicing system

  b. Tail wing deicing system

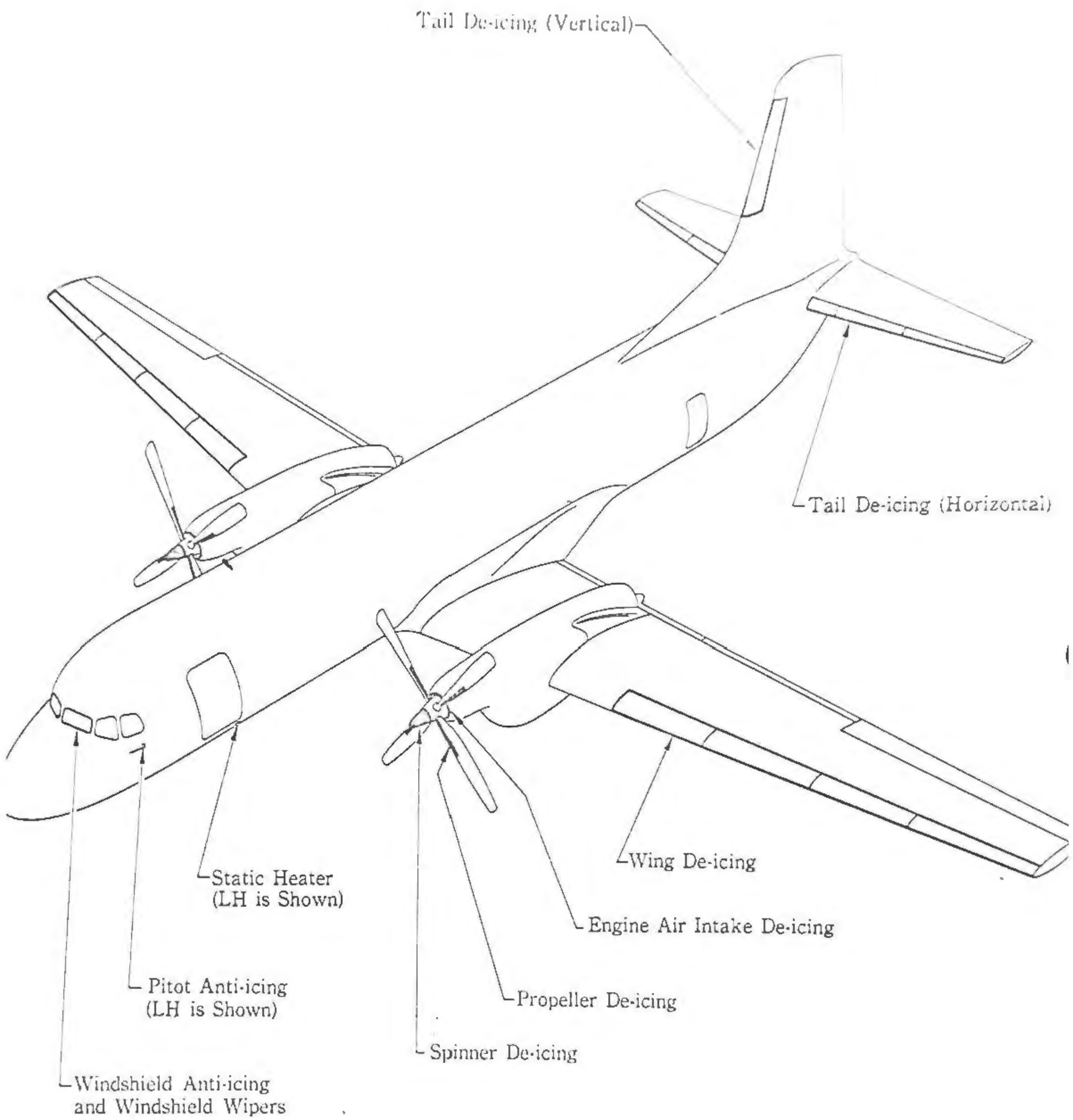
(2) Engine Air Intake Anti-icing System

(3) Propeller Blade and Spinner Anti-icing System

(4) Pitot Tube and Static Port Anti-icing System

(5) Windshield Anti-icing System

The anti-icing is accomplished by means of electric heaters in these systems, excepting the airfoil anti-icing system in which rubber boots are utilized for the purpose.


Tail De-icing (Vertical)
Tail De-icing (Horizontal)
Static Heater (LH is Shown)
Wing De-icing
Engine Air Intake De-icing
Pitot Anti-icing (LH is Shown)
Propeller De-icing
Spinner De-icing
Windshield Anti-icing and Windshield Wipers

Ice and Rain Protection System

Figure 13-1

13.2 Airfoil Anti-icing System (Rubber Boots Type)

13.2.1 Outline

In the airfoil anti-icing system, rubber boots are provided over ranges from W. Sta. 5,160 to 14,400 in the main wing, from the horizontal H. Sta. 1,000 to 5,850 and from the vertical V. Sta. 1,750 to 4,000 in the tail wing respectively, and these boots are inflated with the bleed air (about 70 psi) from the second stage of the engine compressor to eliminate the ice formed on the leading edge of each wing.

The rubber boots are of two different types, 21S and 22S. Those for the main wing are given an appropriate contour while those for the tail wing are used in their original shape, when they are stuck to their respective areas with cement.

(1) 21S (Spanwise type)

	(Sections)
Main wing, W. Sta. 11,800 to 14,400	D x 2
Horizontal tail wing, H. Sta 3,200 to 5,850	E x 2
Vertical tail wing, V. Sta 1,750 to 4,000	E x 1

(2) 22S (Chordwise type)

	(Sections)
Main wing, W. Sta. 5,160 to 11,800	A,B,C x 2
Horizontal tail wing, H. Sta. 1,000 to 5,850	C,F x 2

As for the sections A through F listed above, the rubber boots cover 8 to 10% of the leading edge of each wing.

The inflation and deflation of these boots are controlled in a definite sequence and with fixed intervals by the electronic timer.

There is additionally provided a cross-feed system to be used in case of single engine operation.

13.2.2 System Operation

The bleed air (about 70 psi) supplied from the second stage of the engine compressor is passed through the vapor filter, reducing its pressure to 18 ± 1 psi by the regulator and relief valve, and, then to the pressure line of the left and right distributor valves to inflate the boots. At the same time, the air with the reduced pressure is forwarded to the ejector, in which it produces a suction pressure of 4 to 6 in.Hg through Venturi effect.

This suction pressure is used to prevent the boots from being inflated by the negative pressure developed on the wing surface during flight.

The switching from inflation to deflation and vice versa is accomplished by actuating the electronic timer with the de-icing master switch so that the solenoid valve of the distributor will be operated to cause the outlet port leading to the rubber boots to be switched from the suction line to the pressure line.

The electronic timer has a "heavy" and a "light" cycle functions, with 60 seconds and 180 seconds forming one cycle respectively. In either case, each inflation time for A through F is 6 seconds, which gives a total inflation time of 36 seconds. This means that the only difference between the "heavy" and the "light" cycle functions is the length of rest intervals, namely, 24 seconds for the former and 144 seconds for the latter.

For fear of failure in the electronic timer, there is provided an override manual switch, the operation of which permits selective inflation of these boots.

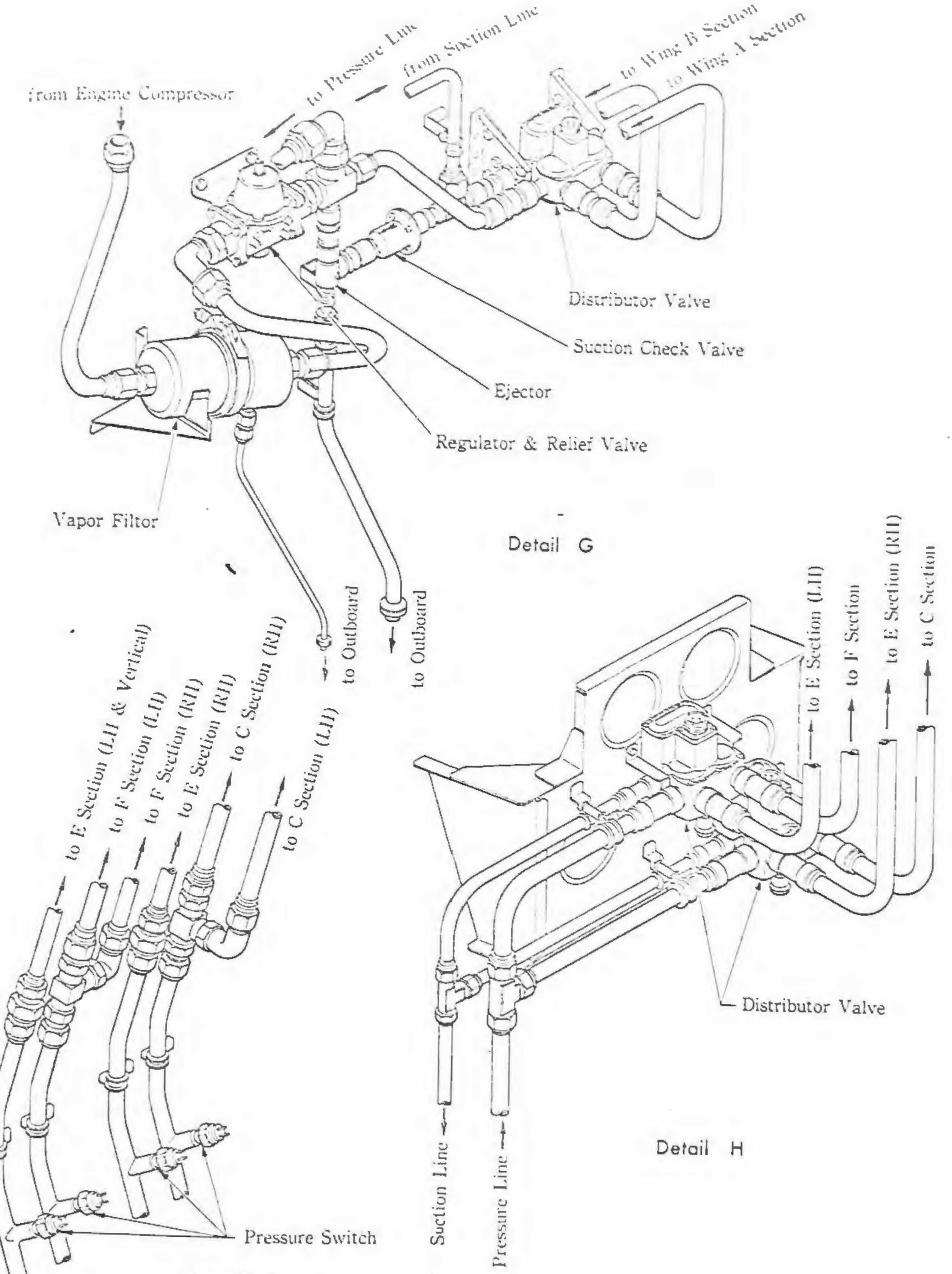
As concerns the safety of the system operation, there are incorporated the relief-valve and check valve in both the pressure line and the suction line to control pressure and prevent backflow in these lines.

For the purpose of ground inspection, there is provided the ground test connection.

Each piping system is provided with a drain port for water drainage.

1.2.3 Component

	Part	Position	Q'ty
1	Regulator & relief valve	Outboard side of nacelle (W.Sta. 3,334-4,000)	2
2	Vapor filter	"	2
3	Check valve (pressure)	Nacelle	2
4	Ejector	"	2
5	Suction relief valve	Wing root	2
6	Check valve (suction)	Nacelle	2
7	Distributor valve	1. Nacelle 2. Wing (W.Sta. 9,600) 3. H.Stab.root	6
8	Electronic timer	Flight control compt.	1



Rubber Boots System - Locating of Component

Figure 13-4

13.2.4 Rubber Boots

A total 13 rubber boots, 7 in type, manufactured by Yokohama Rubber Co. Ltd. are installed according to the following schedule:

	Position	Section	P/N	Q'ty
1	Main wing, No. 3	A	22S-10-1	2
2	" No. 4	B	22S-10-2	2
3	" No. 5	C	22S-10-3	2
4	" No. 6	D	21S-10-4	2
5	Hor. tail wing inboard	C & F	22S-10-5	2
6	Hor. tail wing outboard	E	21S-10-6	2
7	Ver. tail wing	E	21S-10-7	1

These rubber boots are glued with cement (EC-1300L) on the leading edges of the wing and the stabilizers. They contain built-in inflation tubes, which are inflated with the pressure air described previously.

The air connection made of aluminum is connected to the pressure line by means of hose, while it is led into the boots by the manifold tube which is installed at a right angle to the inflation tube.

The rubber boots are inflated individually by the sections (A through F). However, the two boots on the inboard side of the horizontal tail wing (22S-10-5) have two air connections and are internally independent of each other so that the exterior member will function as "F" while the interior member will function simultaneously with "C" (Wing No. 5).

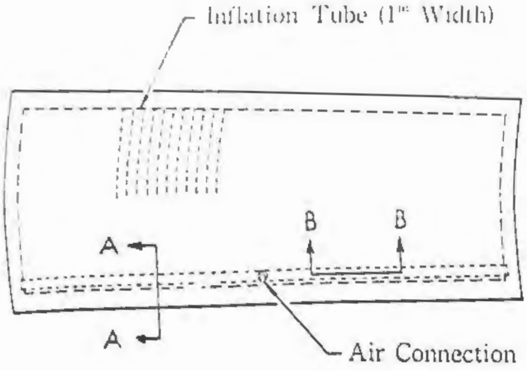
The following tables show the times required for the inflation and deflation of each boots section:

(in seconds)

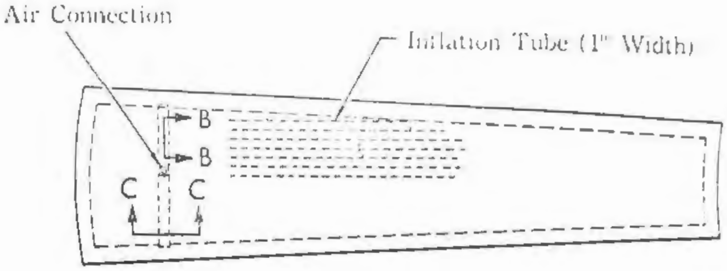
Boots section	A	B	C	D	E	F
Inflation time	2	2	3	3	4	3
Deflation time	8	8	8	10	15	18

The allowable range of cycle time is 60 ± 6 seconds in the heavy cycle and 180 ± 18 seconds in the light cycle.

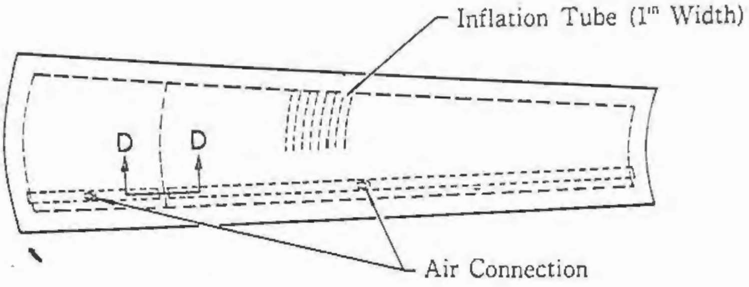
The rubber boots are glued with cement (EC- 1300L or EC-1403) and conductive cement (A-56B), and coated with a protective sealant (PR380 or EC-801A). When they are to be removed for replacement, Toluol or Methyl Ethyl Ketone(MEK) is used to facilitate the removal.



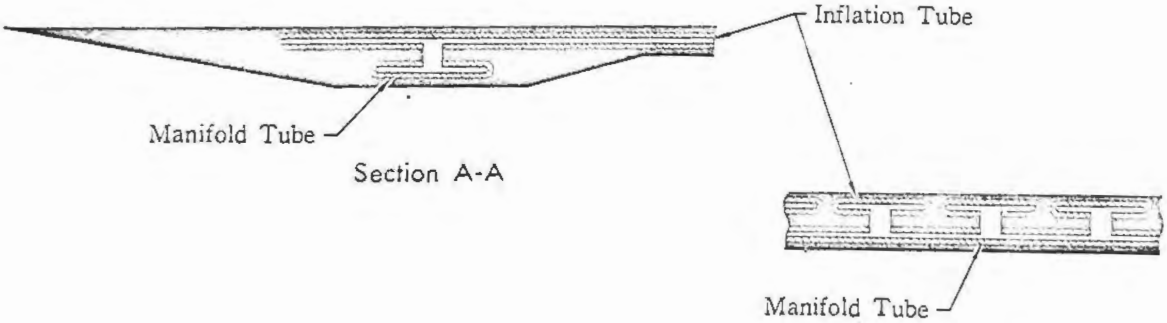
Type 22S Rubber Boots Construction (1)



Type 21S Rubber Boots Construction

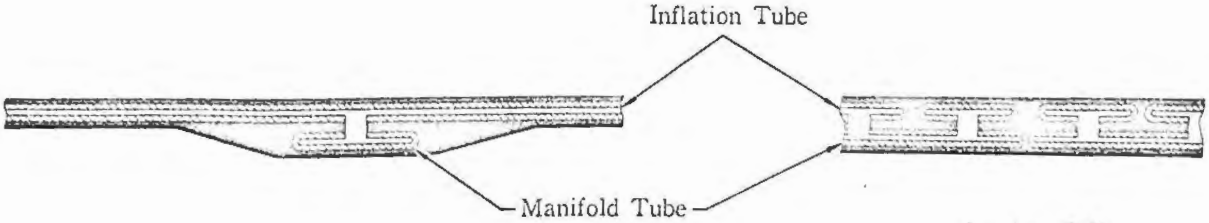


Type 22S Rubber Boots Construction (2)
(22S-10-5-1/-2 Only)



Section A-A

Section B-B



Section C-C

Section D-D

Rubber Boots Construction
Figure 13-5

13.2.5 Regulator & Relief Valve

The regulator & relief valve is provided one each between the wing box beams on the outboard side of the left and the right nacelles (W. Sta. 3,334 to 4,000). It is intended to get compressed air of 18.0 ± 1 psi from the bleed air and contains a relief valve which is operated when the regulator goes out of order.

(1) Part No.: 38E59-1 (Bendix)

(2) Input pressure: 30 to 150 psig

(3) Regulated pressure: 18.0 ± 1 psig

(4) Air temperature: -65°F to 550°F

(5) Relief pressure: 20.0 ± 0.75 psig

13.2.6 Distributor Valve

The distributor valve is composed of the pressure inlet port, the suction outlet port, the ports "A" and "B" leading to the rubber boots, the exhaust port and the two solenoids "A" and "B". The alternate switching of boots between the pressure and the suction is accomplished by means of the timer-controlled cycle or by the operation of the manual switch.

The pressure of 18.0 ± 1 psi is applied to the inlet port and the suction of 4 to 6 in. Hg on the outlet port respectively. When the solenoid valve is not energized, any excess pressure is released through the exhaust port.

The ports "A" and "B" and the solenoids "A" and "B" are connected to the corresponding lines to actuate boots.

(1) Part No.: 1532-3 (Bendix)

(2) Suction range: 4 to 6 in.Hg

(3) Pressure range: 8 to 22 psig

(4) Voltage: DC 28V

13.2.7 Vapor Filter

The vapor filter is attached in front of the regulator & relief valve provided between the wing box beams on the outboard side of the nacelle (W. Sta 3,334 to 4,000) and it functions to relieve the engine bleed air of moisture and other foreign matter contained in it.

Structurally, the conical screen creates a turbulent flow of the bleed air so as to remove the moisture in the form of water drops and the cotton cellulose filter removes the remaining moisture and other foreign substance from the passing bleed air.

This Bendix-made vapor filter is assigned Part No. 44E03-1 and has a structure permitting the replacement of filter elements.

13.2.8 Suction Relief Valve

The suction relief valve is attached to the suction line at the fuselage-wing joint section (on the fuselage side of W. Sta. 0) and serves to prevent abnormal increase in the difference between the line pressure and the atmospheric pressure,with the relief pressure adjustable in the range of from 4.0 to 7.0 in.Hg. Here, the relief pressure is regulated at 6.0 in.Hg. This is made by Bendix and assigned Part No. 691-14.

13.2.9 Indication System

The indication system consists of the indication light system to indicate the operation of rubber boots of each section and the pressure indication system to indicate the pressure of the pressure lines and the suction lines in the system.

(1) Indication Light System

On the cockpit overhead panel, there are installed 6 lights corresponding to the 6 rubber boots sections "A" through "F". They come on through two different sensing means: The lights for the boot sections "A", "B" and "D" on the main wing are lighted by the electric current entering into the distributor solenoid valve, while the sections "E", "F" and "C" (combination) are energized by the pressure (10 ± 1 psi) developed within the pressure line leading to the corresponding boots.

In the sections "A", "B" and "D", therefore, it is possible that even when the indication lights are on, the boots may not be functioning, for instance, due to the troubles in the distributor valves. Use of the pressure switch as the sensing means is avoided here, because such failure can be checked visually from the cockpit.

(2) Pressure Indication System

In the pressure indication system, the difference between the pressure in the pressure line and suction line of the rubber boots system and the static pressure in the alternate static line are detected by the corresponding transmitters and indicated on the pressure gauge and the suction gauge found on the overhead panel respectively.

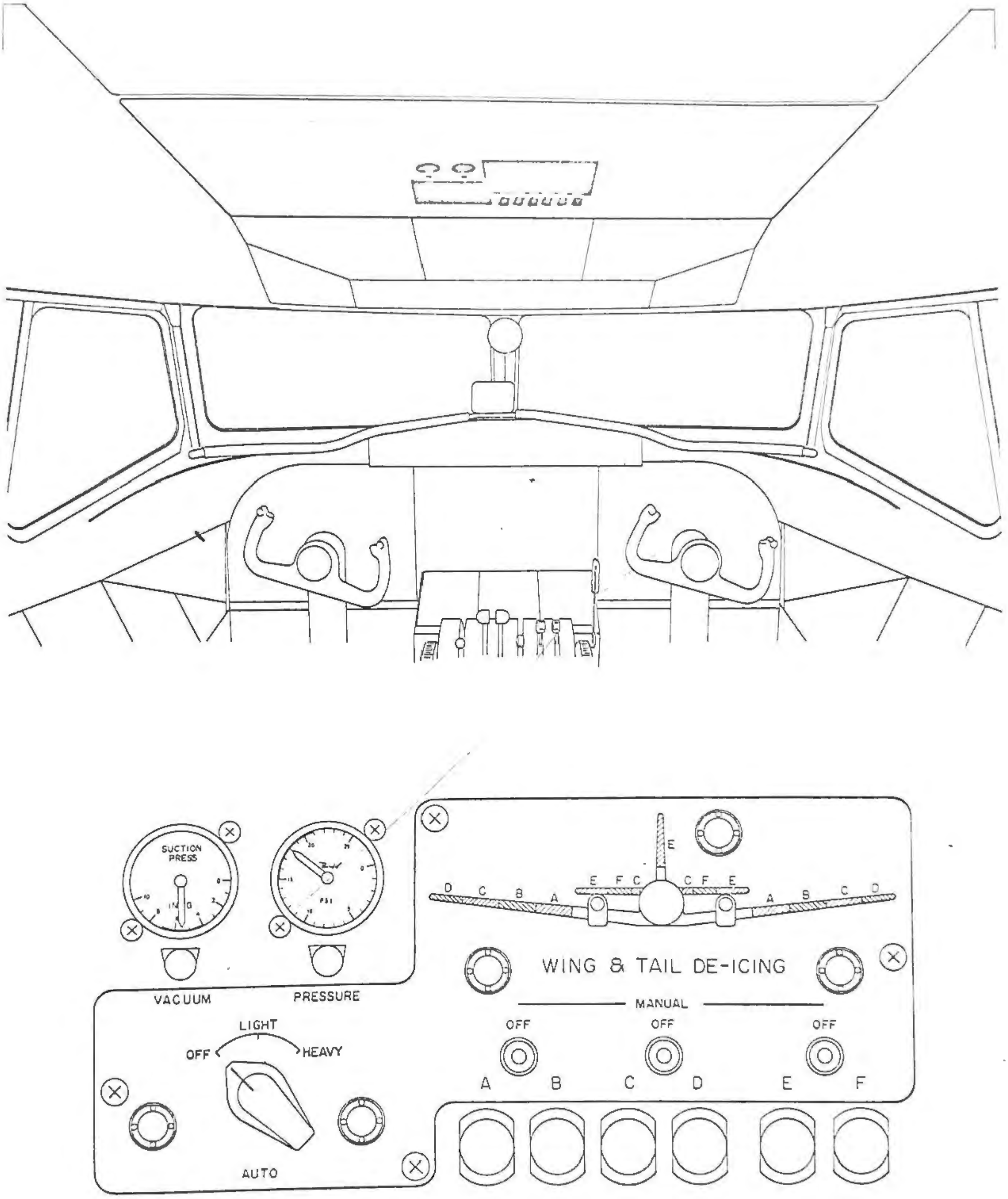
The pressure and suction for these transmitters are taken from the cross-feed section of the center wing so as to indicate the said difference at all times throughout the entire duration of engine operation.

13.2.10 Transmitter

There are two transmitters, one for the pressure line and the other for the suction line, and they are located in the flight control compartment.

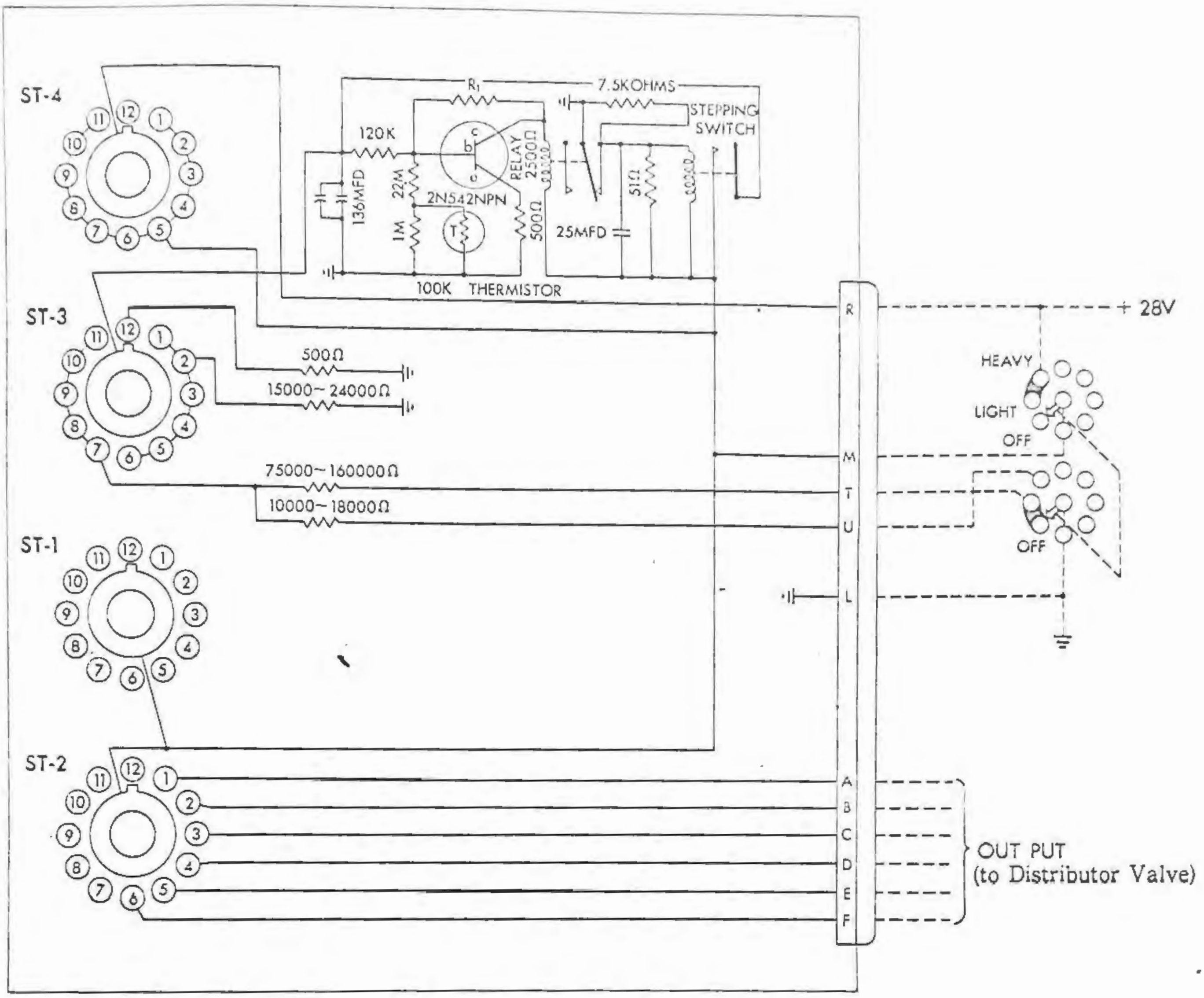
		Pressure	Suction
(1)	Part No.	7709-1-A5-1	7725-55-A5-1
(2)	Input	26V 400 c/s	26V 400 c/s
(3)	Range	0 to 25 psi	0 to 10 psi
(4)	Temperature	-54 to +71°C	-54 to +71°C

The transmitter is of an autosyn synchronous type having two built-in bellows assemblies as the pressure sensing elements, and each of them has two ports for fitting. Through these ports, the bellows assemblies are actuated so that the shaft and selector assembly is operated through the linkage to give an angle of rotation to the synchronous assembly rotor, the angular motion of which is transmitted electrically to the gauge.



Wing & Tail De-icing Instrument Panel

Figure 13-7

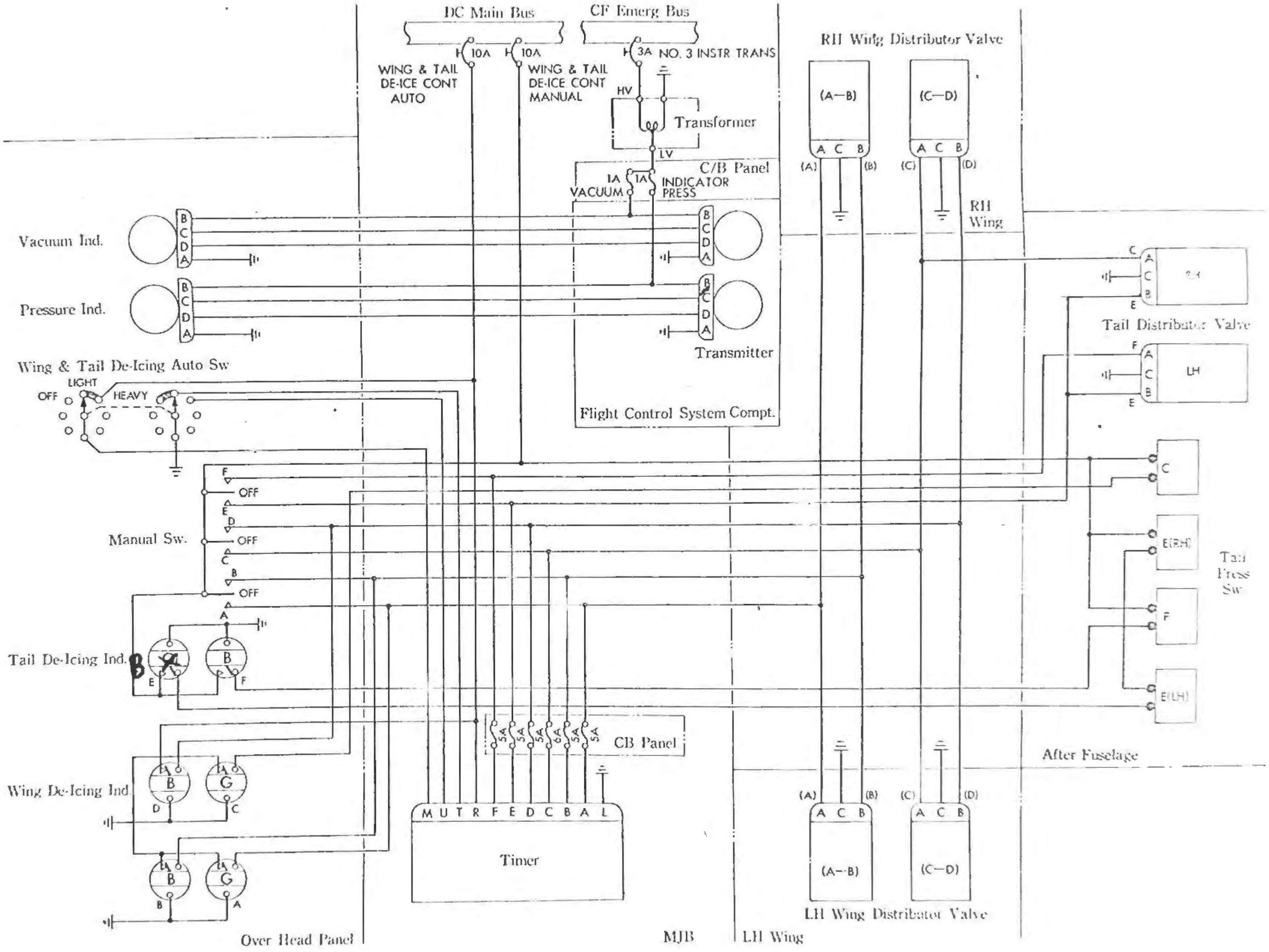


PINS ENERGIZED	HEAVY ICE	LIGHT ICE
A	6	6
B		6
C	6	6
D	6	6
E	6	6
F	6	6
DWELL	24	144
TOTAL	60	180

Timing Sequence

Electrical Timer Schematic Diagram

Figure 13-8



Rubber Boots Electrical System Schematic

Figure 13-9

13.3 Engine Air Intake Anti-Icing System

13.3.1 Outline

This system is composed of the heating circuit of the heater element embedded in the interior of the peripheral portion of the engine air intake to be heated by the WFAC power source, the current balance unit for controlling the load of electric power supplied to the circuit, the cyclic timer for controlling the heating time, and similar other controlling units and their corresponding indication units.

The heater elements used in this system are of two different types, continuous and cyclic.

This anti-icing system has one independent system for each of the two engines and permits cross feeding so that the anti-icing operation will be continued if the power source or the cyclic timer, if either of the systems, should have any trouble.

13.3.2 Principal Components.

This system has an wiring system commonly used by the propeller anti-icing system to be described later. The power source and the control system have components in common.

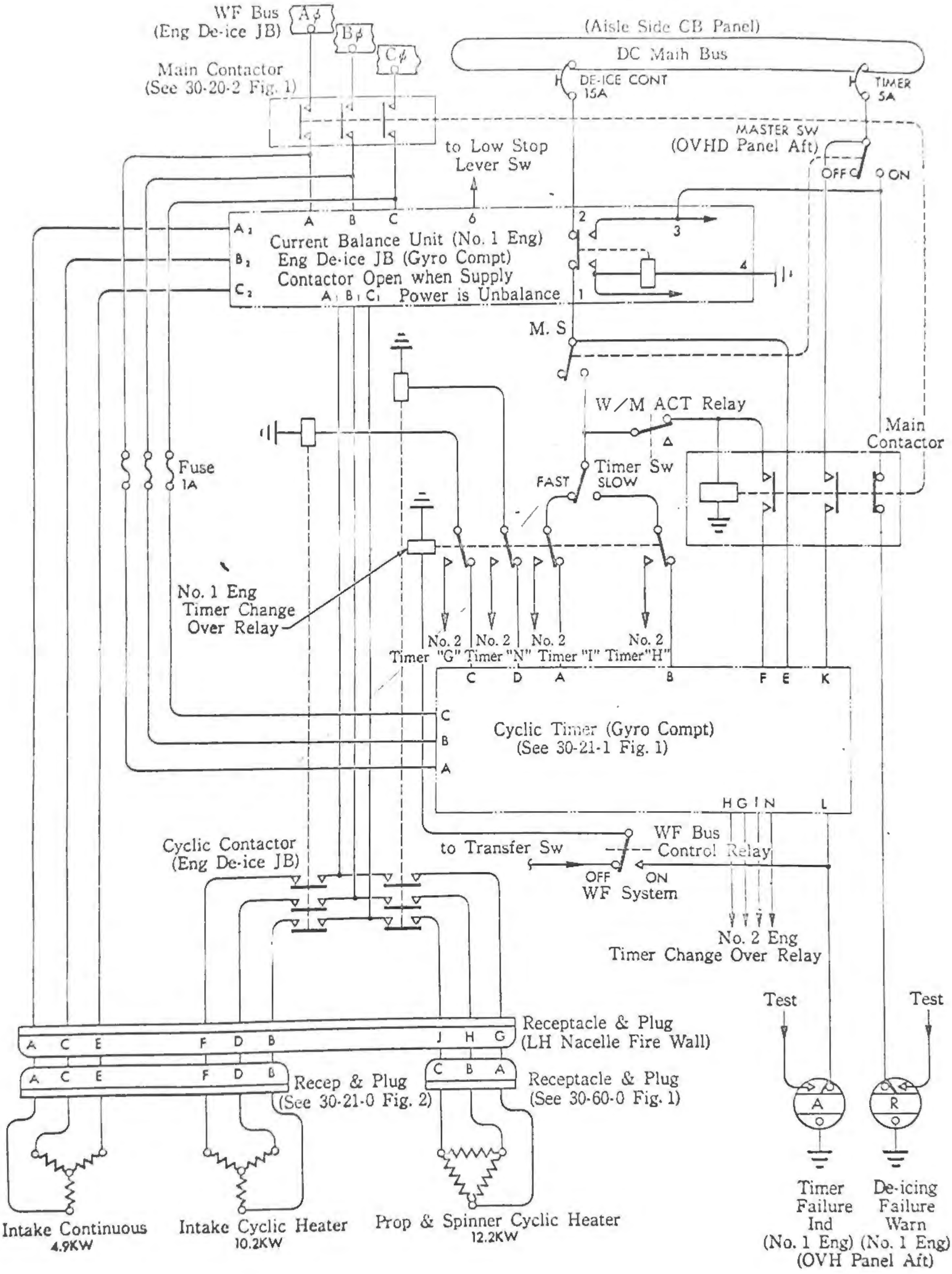
Part name	Station	Q'ty/Ship
Continuous heater element	Both engine cowling	2
Cyclic heater element	"	2
Current balance unit	Flight control compt	2
Cyclic timer	"	2
Main contactor	"	2
Cyclic contactor	"	4*
De-ice fail light	Cockpit overhead panel	2
Timer fail light	"	2
Cyclic timer switch	"	1

* Of the four contactors, two are for the propeller and spinner.

13.3.3 System Operation

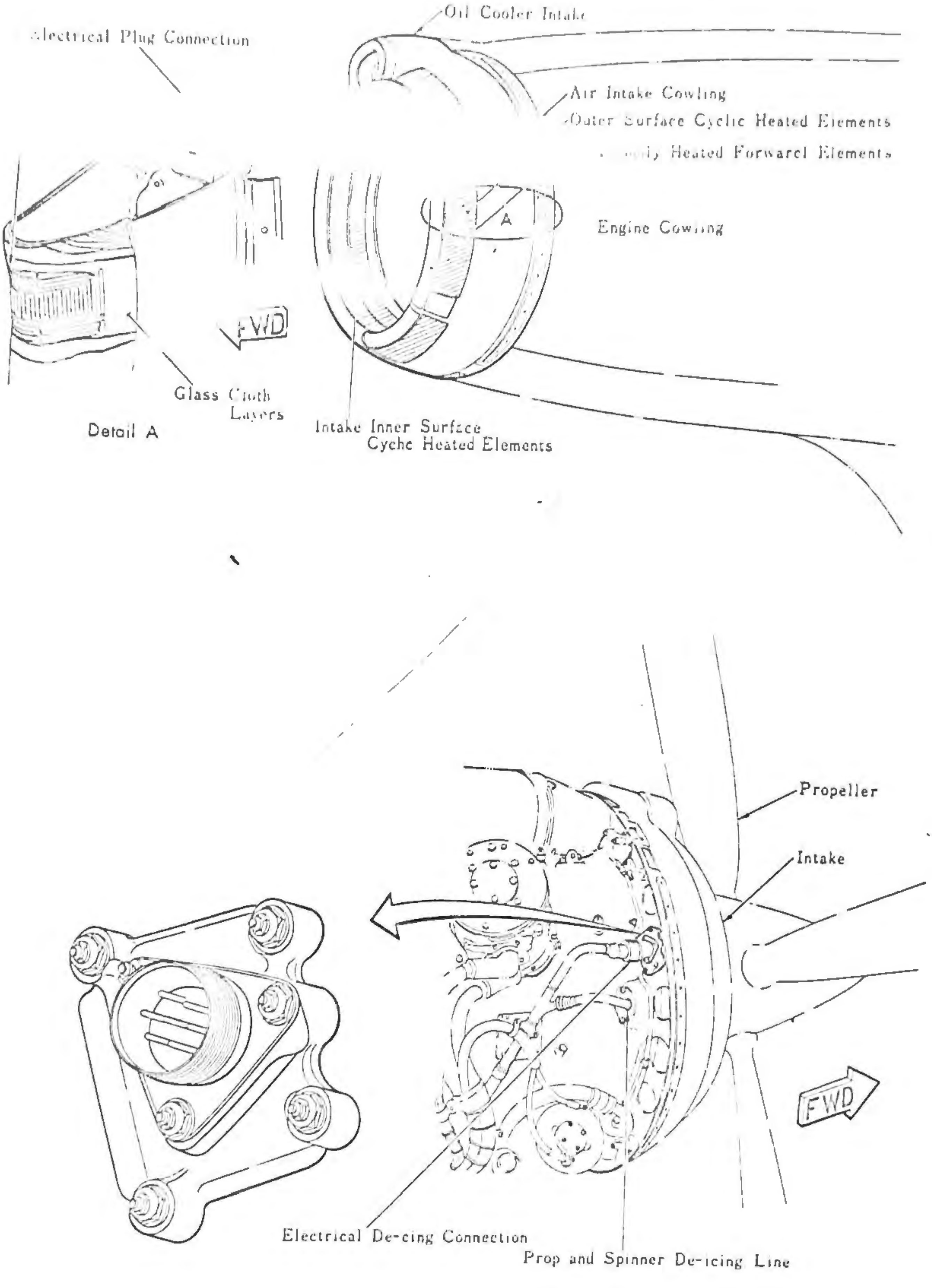
Closing the "Engine De-Ice Master Switch" on the cockpit overhead panel puts the main contactor in its ON position and consequently establishes a circuit to the cyclic timer. The moment the cyclic timer is operated, the WF power source is connected to the current balance unit through the main contactor.

To this main contactor are connected two circuits: One is led directly to the engine air intake continuous heater, while the other is branched and led through independent cyclic contactors to the engine air intake



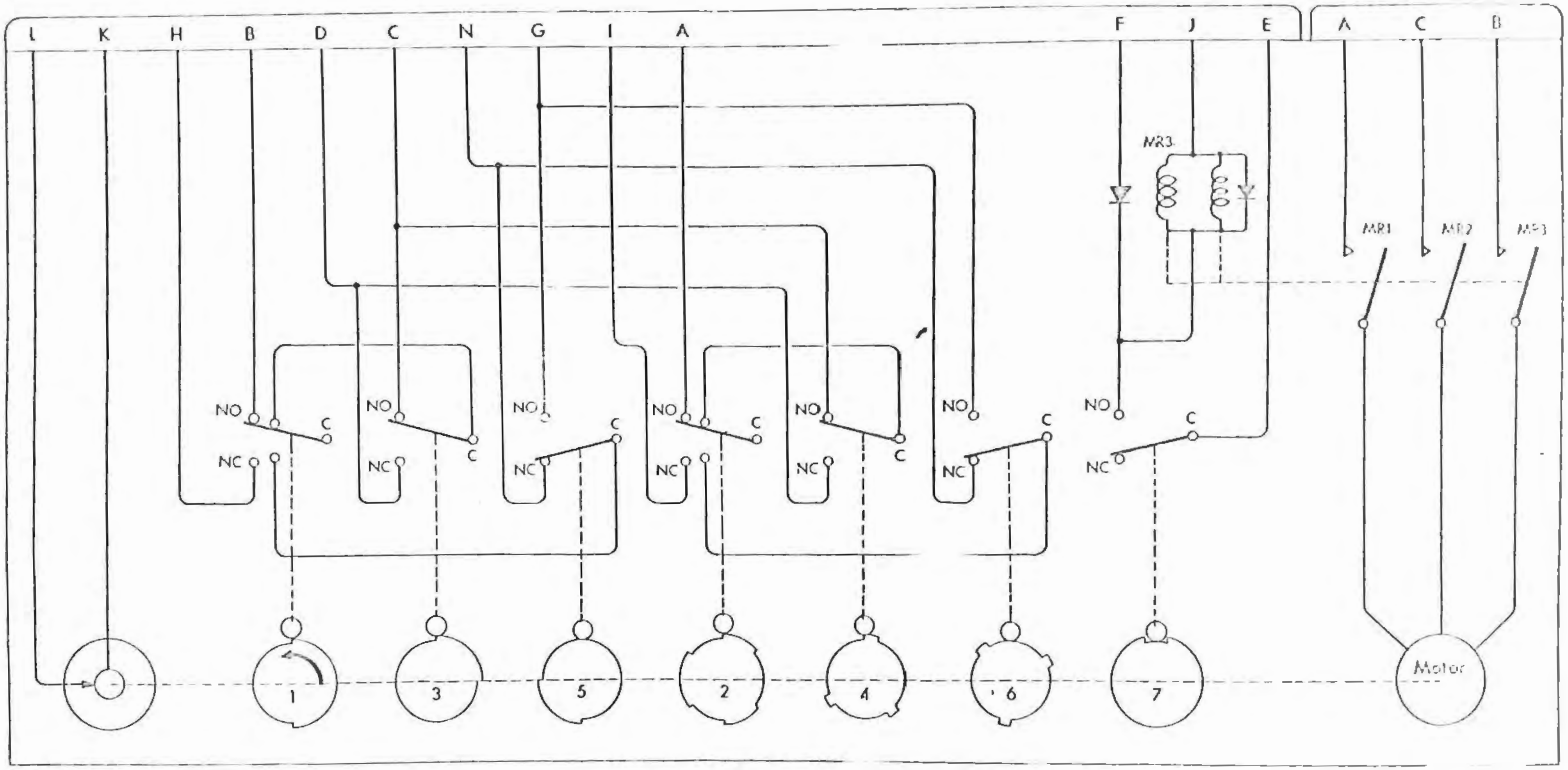
Engine Intake and Propeller Anti-icing System Schematic

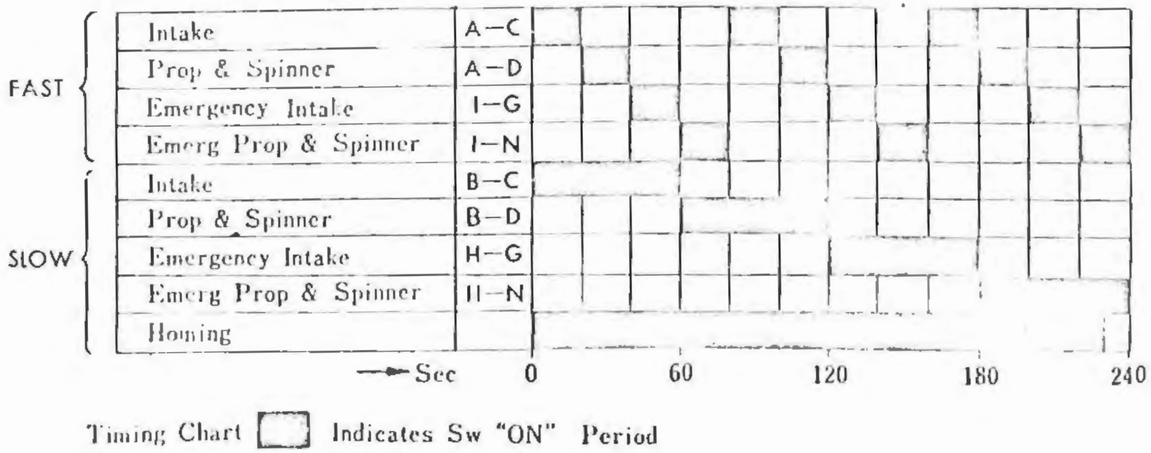
Figure 13-10


Electrical Plug Connection
Oil Cooler Intake
Air Intake Cowling
Outer Surface Cyclic Heated Elements
Heated Forward Elements
A
Engine Cowling
FWD
Glass Cloth Layers
Detail A
Intake Inner Surface Cyclic Heated Elements
Propeller
Intake
FWD
Electrical De-cing Connection
Prop and Spinner De-icing Line

Engine Air Intake Anti-Icing

Figure 13-11





Cycling Timer Schematic Diagram

Figure 13-13

Chapter 15 FIRE PROTECTION SYSTEM

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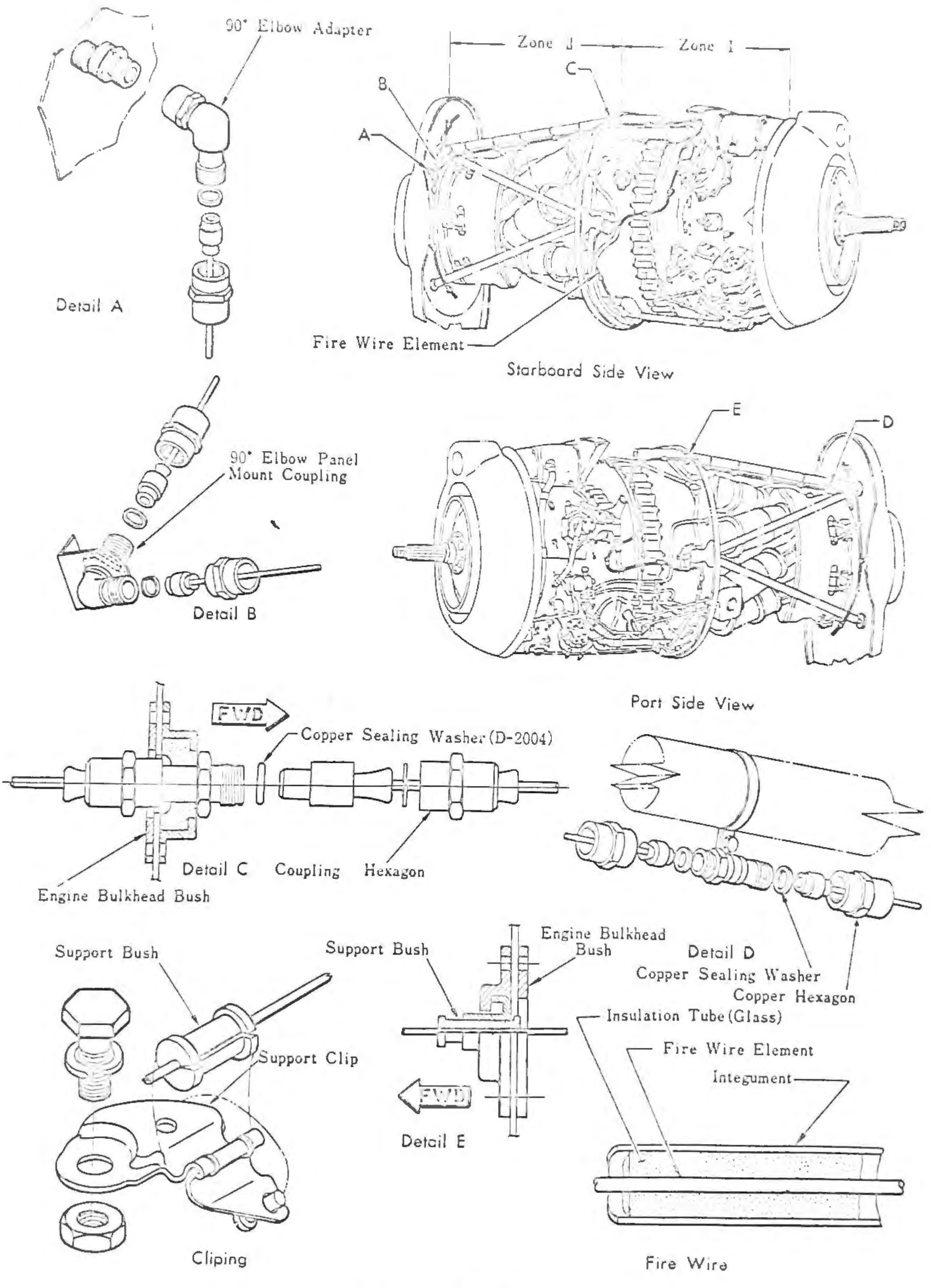
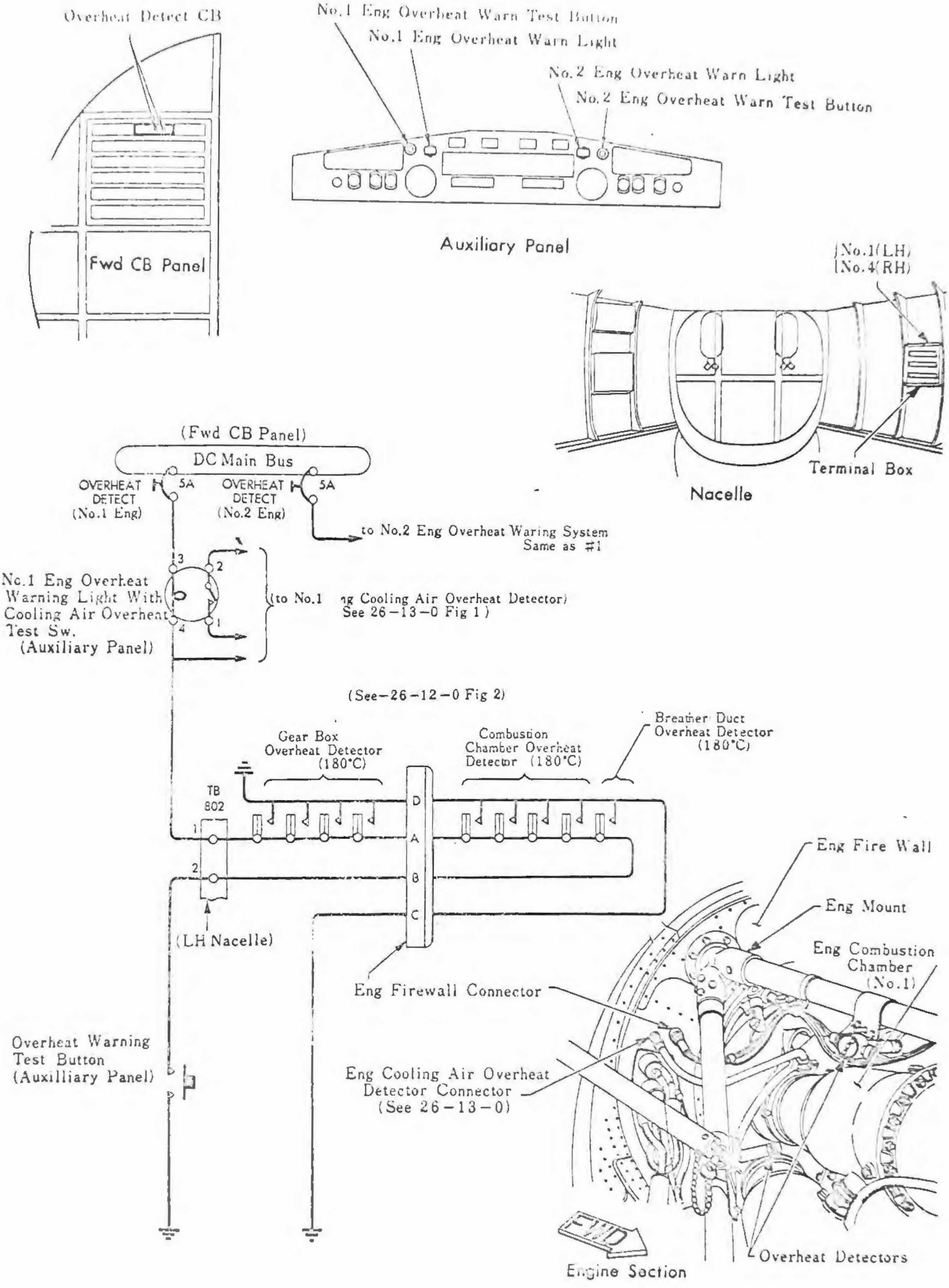
15.4.2 Engine Fire Extinguishing System 12
15.4.3 Cabin Fire Extinguishing System 12



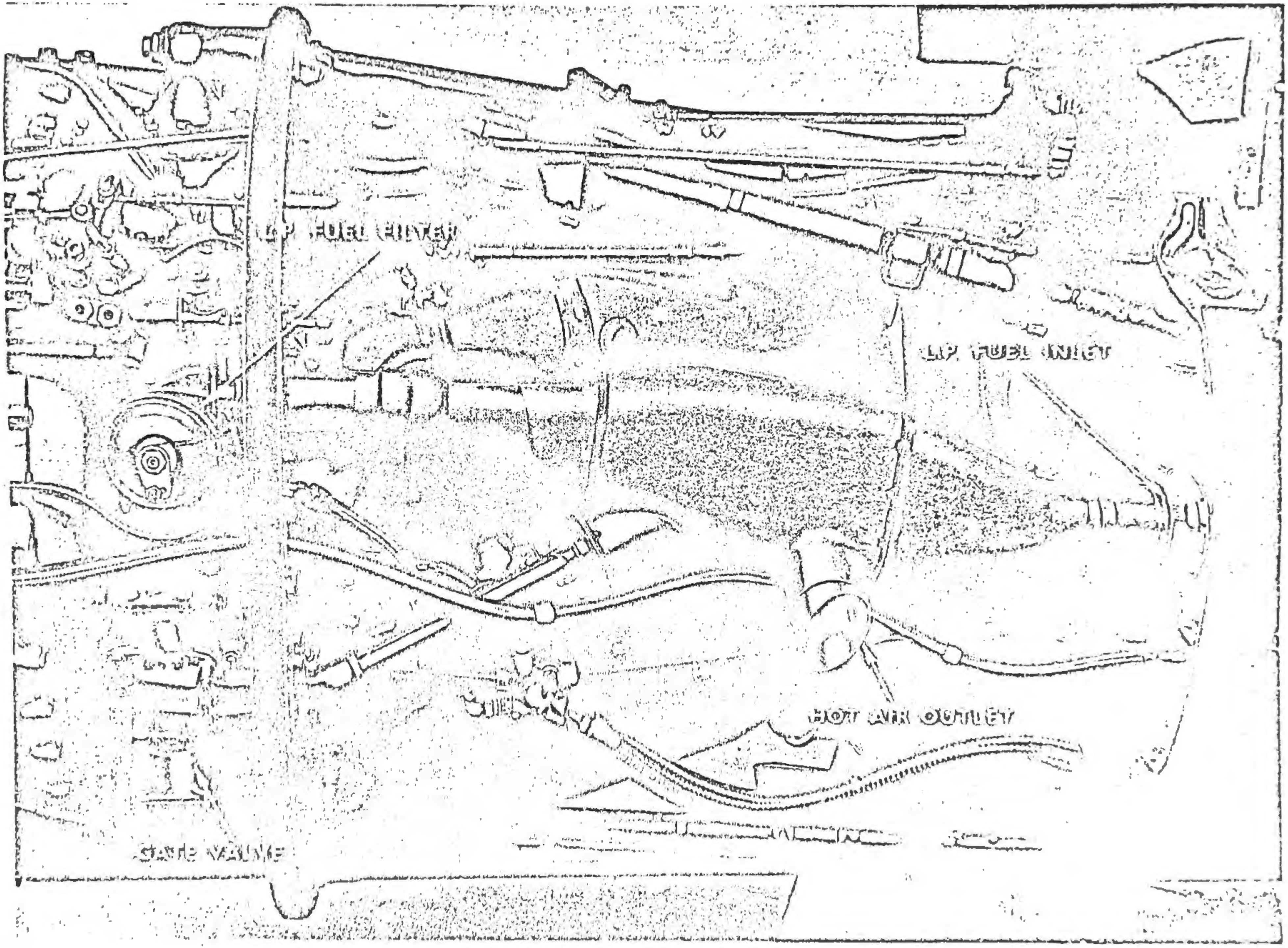
Engine Fire Wire Element

Figure 15-3


Overheat Detect CB
Fwd CB Panel
No.1 Eng Overheat Warn Test Button
No.1 Eng Overheat Warn Light
No.2 Eng Overheat Warn Light
No.2 Eng Overheat Warn Test Button
Auxiliary Panel
No.1(LH)
No.4(RH)
Terminal Box
Nacelle
(Fwd CB Panel)
DC Main Bus
OVERHEAT DETECT (No.1 Eng)
5A
OVERHEAT DETECT (No.2 Eng)
5A
to No.2 Eng Overheat Waring System Same as #1
No.1 Eng Overheat Warning Light With Cooling Air Overheat Test Sw. (Auxiliary Panel)
3
2
4
1
(to No.1 ng Cooling Air Overheat Detector) See 26-13-0 Fig 1)
(See-26-12-0 Fig 2)
Gear Box Overheat Detector (180°C)
Combustion Chamber Overheat Detector (180°C)
Breather Duct Overheat Detector (180°C)
TB 802
1
2
D
A
B
C
(LH Nacelle)
Eng Firewall Connector
Overheat Warning Test Button (Auxiliary Panel)
Eng Cooling Air Overheat Detector Connector (See 26-13-0)
Eng Fire Wall
Eng Mount
Eng Combustion Chamber (No.1)
FWD
Overheat Detectors
Engine Section

Engine Overheat Warning System

Figure 15-5



FUEL HEATING SYSTEM

Fig. 4-55

the starboard of the cabin, are the sensors which send the room temperature signals continuously through an electric resistor to the temperature controller.

(2) Temperature Anticipator

Located at the upstream ends of the conditioned air ducts of the cockpit and cabin under the floor, are the temperature anticipators which detect the temperature difference of air flowing through the ducts, anticipate how the cabin temperature varies in several minutes, and prevent the overshoot phenomenon which occurs because of a long time delay before the room temperature reaches the preset value.

The anticipator consists of a pair of thermistors, one naked and the other covered. These are inserted in two adjoining sides of the bridge circuit. If the room temperature is constant in the preset condition, the thermistors do not have any effects on the circuit. If a temperature change is given, the covered thermistor senses it later than the actual temperature change. This slows down the temperature change, preventing overshooting.

12.5.6 Valve Mechanism and Control

This consists of a temperature control composed of a bridge circuit from which signal current corresponding to the difference between the selected and sensed temperatures is derived to fill up the gap between them and a magnetic amplifier which amplifies the signal current to a level enough for operating the valves, and four valves which are actuated, based on the signal.

(1) Cockpit

Anti-ice valve, air mixing valve

(2) Cabin

Back pressure valve, air mixing valve

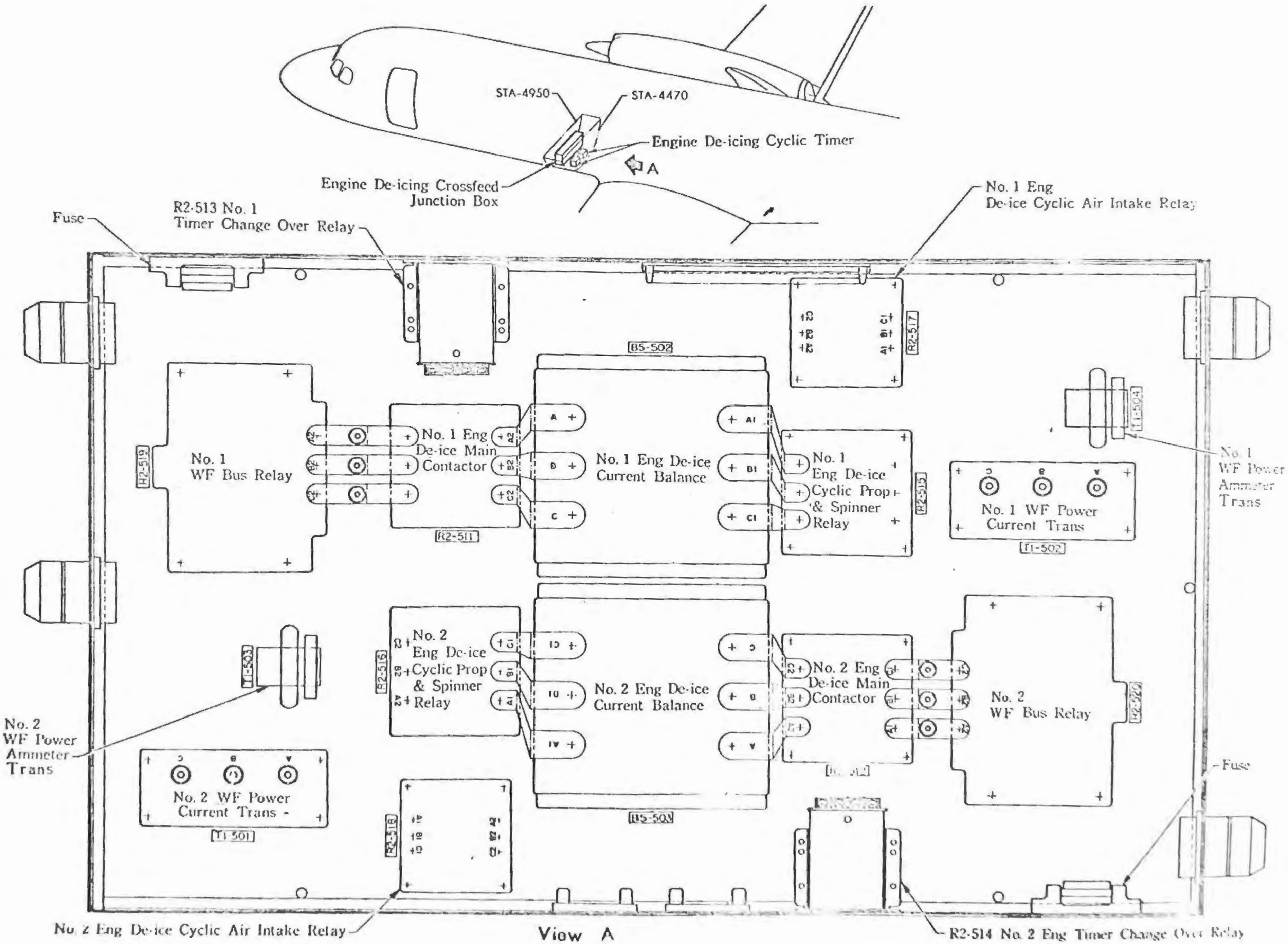
The anti-ice valve is operated by the anti-ice sensor located at the outlet of the water separator for de-icing the water separator of the cooling system so that the cockpit temperature controller contains two bridges, an air conditioning bridge and an anti-ice bridge.

In this anti-ice bridge, a cockpit temperature sensor is also included which generates air conditioning signal as well. Operation of two valves each in the cabin and cockpit is performed in the following order:

(1) Cabin

a. Heat

First, the air mixing valve is fully opened and then the back


STA-4950
STA-4470
Engine De-icing Cyclic Timer
A
Engine De-icing Crossfeed Junction Box
Fuse
R2-513 No. 1 Timer Change Over Relay
No. 1 Eng De-ice Cyclic Air Intake Relay
R2-517
B5-502
No. 1 WF Bus Relay
R2-519
No. 1 Eng De-ice Main Contactor
R2-511
No. 1 Eng De-ice Current Balance
No. 1 Eng De-ice Cyclic Prop & Spinner Relay
R2-515
T1-504
No. 1 WF Power Ammeter Trans
No. 1 WF Power Current Trans
T1-502
T1-503
No. 2 Eng De-ice Cyclic Prop & Spinner Relay
R2-516
No. 2 Eng De-ice Current Balance
No. 2 Eng De-ice Main Contactor
No. 2 WF Bus Relay
R2-520
No. 2 WF Power Ammeter Trans
No. 2 WF Power Current Trans
T1-501
R2-518
B5-503
Fuse
No. 2 Eng De-ice Cyclic Air Intake Relay
View A
R2-514 No. 2 Eng Timer Change Over Relay

Engine De-icing Crossfeed Junction Box
Figure 13-12

cyclic heater and to the propeller & spinner cyclic heater respectively.

In the case of the cyclic heater, when the cyclic timer switch is turned into either of the two positions "Fast" and "Slow", the cam mechanism in the corresponding timer is operated to actuated the cyclic contactor to connect or cut the electric current from the current balance unit.

This means that the cyclic timer functions not merely to alternately switch the heating circuit of the cyclic heater between the engine air intake and the propeller & spinner but also to permit the cyclic speed to be controlled automatically through the selection of the "Fast" and "Slow" positions of the timer switch to close or open the heating circuit via the corresponding cyclic contactor.

The current balance unit is automatically actuated, whenever there occurs a lack of balance in the supply of power to the heater, to cut off the solenoid contact of the main contactor and protect the AC generator. Besides, it functions to provide required control to make the system operate normally when the supply voltage has not reached the working level on the ground.

When the main contactor fails to operate normally, the de-icing failure warning light comes on to indicate the presence of abnormal condition in the circuit.

The timer failure light comes on when the main contactor is actuated to close the circuit, while it goes out when the cyclic timer is actuated to allow the cam inside to start rotating and, consequently, the centrifugal switch is operated to open the circuit.

The switching cycle of the timer is 80 seconds when the cyclic switch is placed in its "Fast" position and 240 seconds when the switch is placed in its "Slow" position.

13.3.4 Cross-feed of System

The engine & propeller anti-icing system is provided independently for each of the two engines. The two systems are so designed as to permit cross-feeding, in case any failure occurs in the WF power source or the cyclic timer belonging to either of the engines.

(1) In case of failure in the timer

When the timer goes out of order and ceases its movement, the built-in centrifugal switch is closed and the timer fail light comes on and, at the same time, the timer changeover relay is actuated through the WF bus control relay, with the result that the intermittent current from the timer on the other side begins to control the cyclic contactor on the defective side to automatically continue the anti-icing operation.

(2) In case of failure in the WF power source

When either of the alternators goes out of order, the WF transfer switch must be placed in the "Trans." position. This switching permits the WF power to be transferred and, at the same time, actuates the timer changeover relay via the WF bus control relay. Thus, the system is allowed to continue its normal function in the same way as in (1) above.

13.3.5 Heater Element (Spray Mat)

This heater element is an electric heater mat called "spray mat", which is composed of a laminated base coat of resin-glass cloth, a heating element of sprayed metallic sheet, and a top coat of resin-glass cloth. Externally, this element is protected with a layer of stone guard which prevents any mechanical damage and further covered with a coat of corrosion proof paint for ensuring resistance to corrosion. This mat contains a thermostat for the prevention of excessive heating.

13.4 Propeller Anti-Icing System

13.4.1 Outline

This system forms a part of the engine air intake anti-icing system described in the preceding section, and it is divided into the anti-icing heater for the propeller blade (to 40% of the total blade length from the root) and that for the spinner. This system shares the wiring and the control system with the engine air intake system. The difference is that this system has only the cyclic heaters but lacks the continuous heaters.

The power consumption of this system is WF 12.2 KW. The electric current flows to the cyclic heater (10.2 KW) of the engine air intake and to the cyclic heater of this system alternately to do the required heating.

13.4.2 System Operation

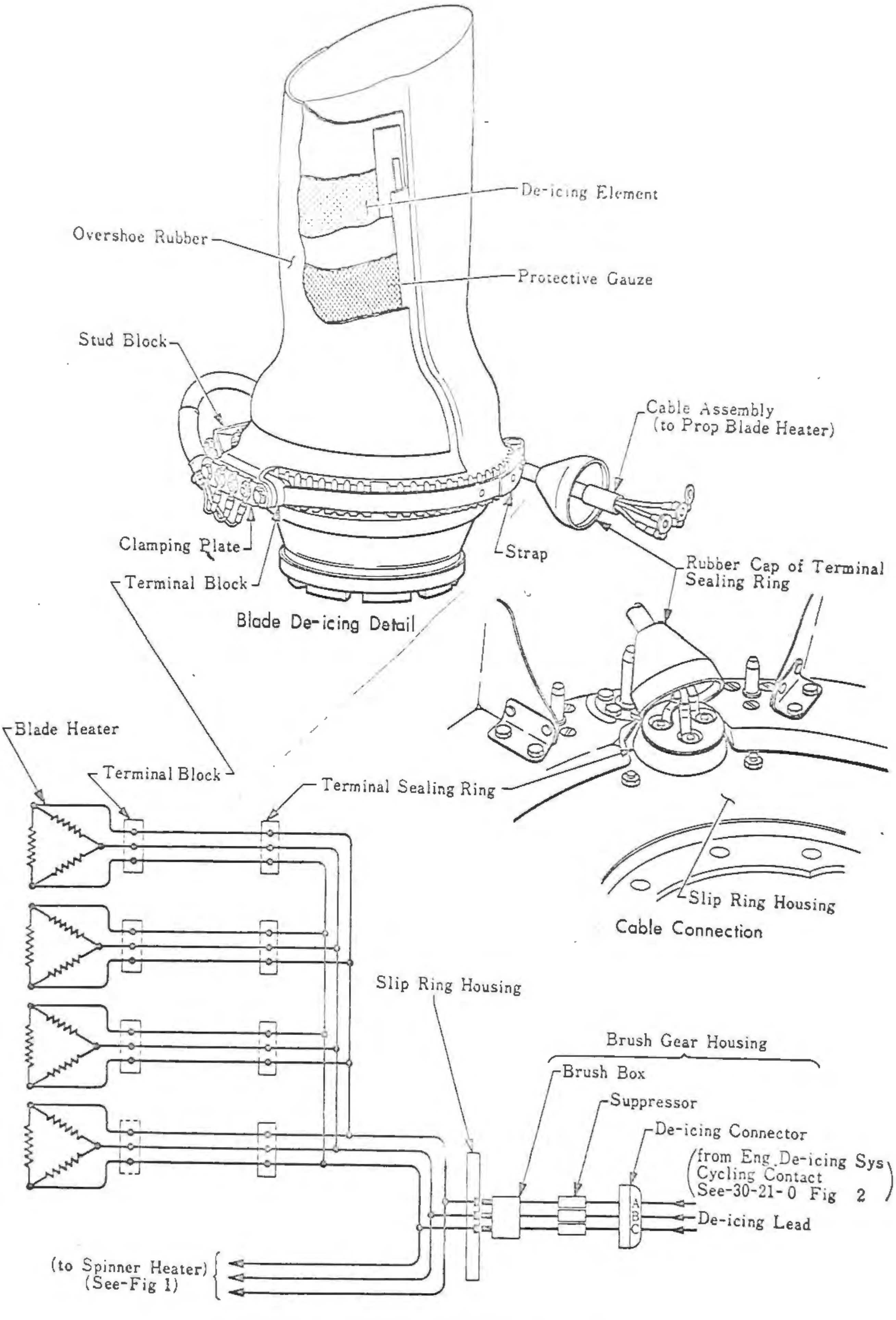
This system is operated by turning on the engine de-ice master switch of the same system as that of the engine air intake found on the cockpit aft RH side overhead panel.

The wire running through the hole on the right side of the air intake extends to the brush gear housing at the end of the engine, and it further goes through the supressor and the brush box and, via the medium of the slip ring housing that rotates with the propeller, reaches the three fixed contacts in front of the slip ring housing. When the spinner is fixed, these fixed contacts are brought into connection with the three spring contacts to permit the electric power to flow to the corresponding heater elements of the spinner.

The heating of the spinner is accomplished by the circular nose element at the globular end section and the three radial elements on the rear periphery.

The element is produced by interweaving resistant wires in a fabric of glass filaments and molding this fabric in rubber. This element is cemented on the inside wall of the spinner.

Similarly the heater element of the propeller blade is manufactured by interweaving resistant wires in a fabric of glass filaments and molding the fabric between sheets of rubber, and this element is cemented on the blade. The only difference is that the element for the propeller has a protective gauze of very fine metal wires cemented on the lower side of the external sheet of rubber to function as the de-icing overshoe.



Propeller Blade Anti-icing System Schematic

Figure 13-14

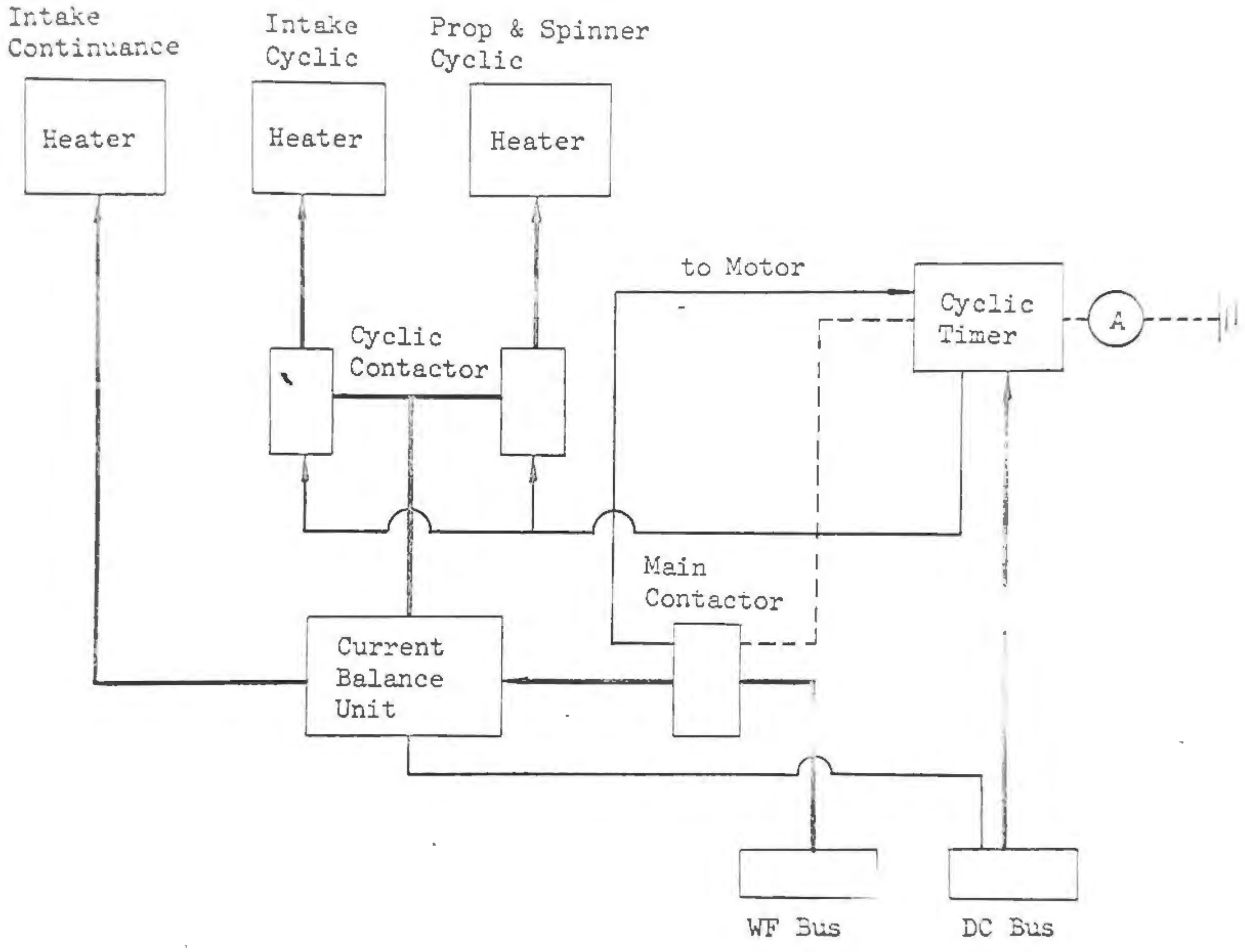
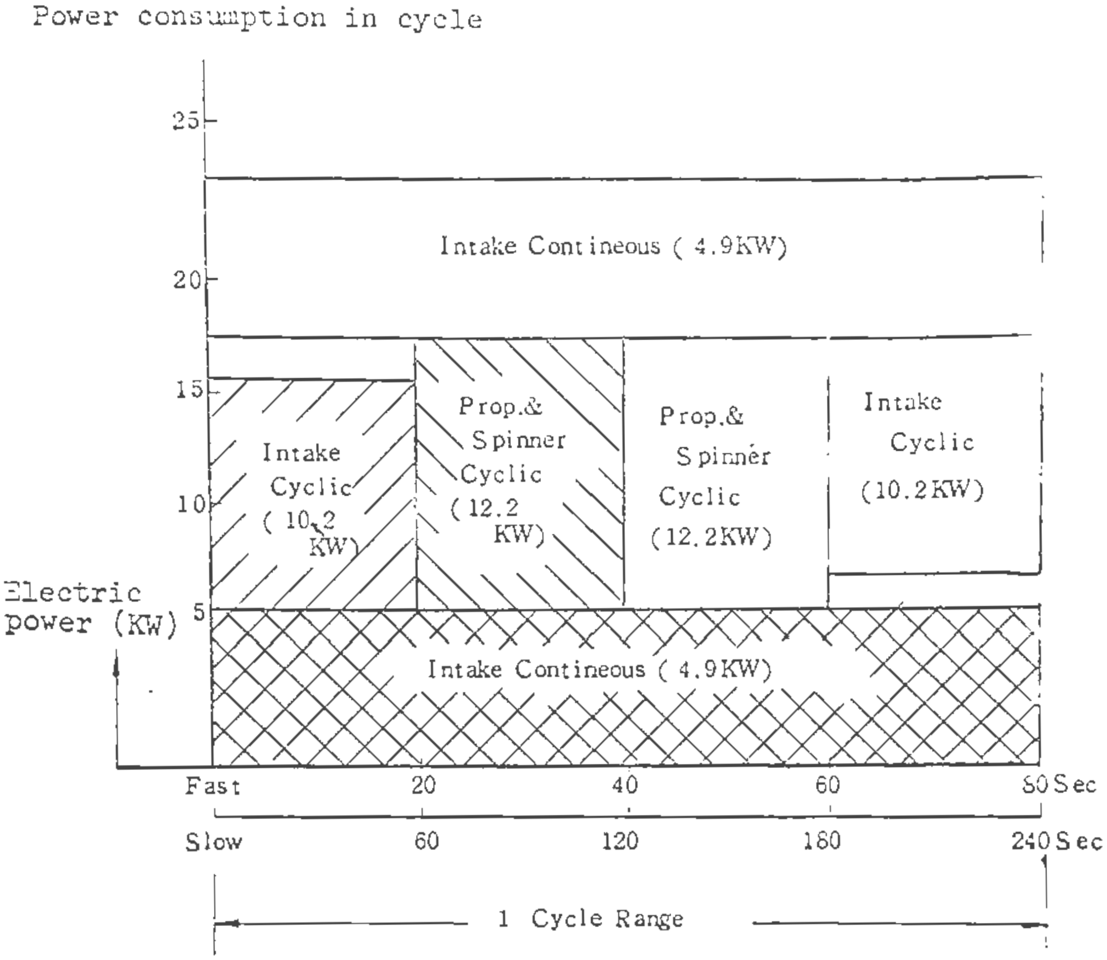

Intake Continuance
Heater
Intake Cyclic
Heater
Prop & Spinner Cyclic
Heater
to Motor
Cyclic Timer
A
Cyclic Contactor
Main Contactor
Current Balance Unit
WF Bus
DC Bus

Figure 13-15

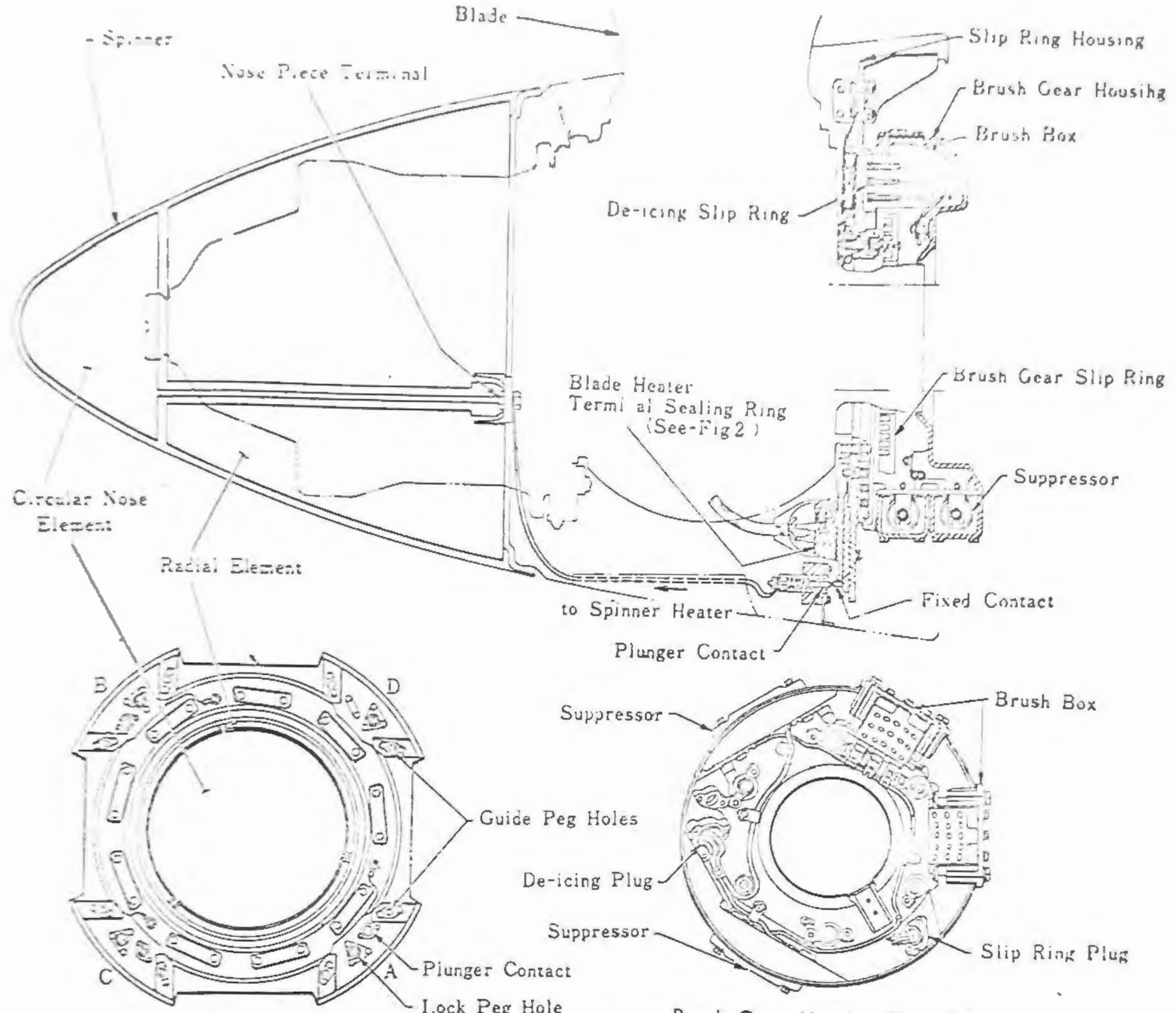


Power consumption

Eng. Intake Contineous Heater : 4.9 KW
Eng. Intake Cyclic Heater : 10.2 KW
Prop. & Spinner : 12.2 KW

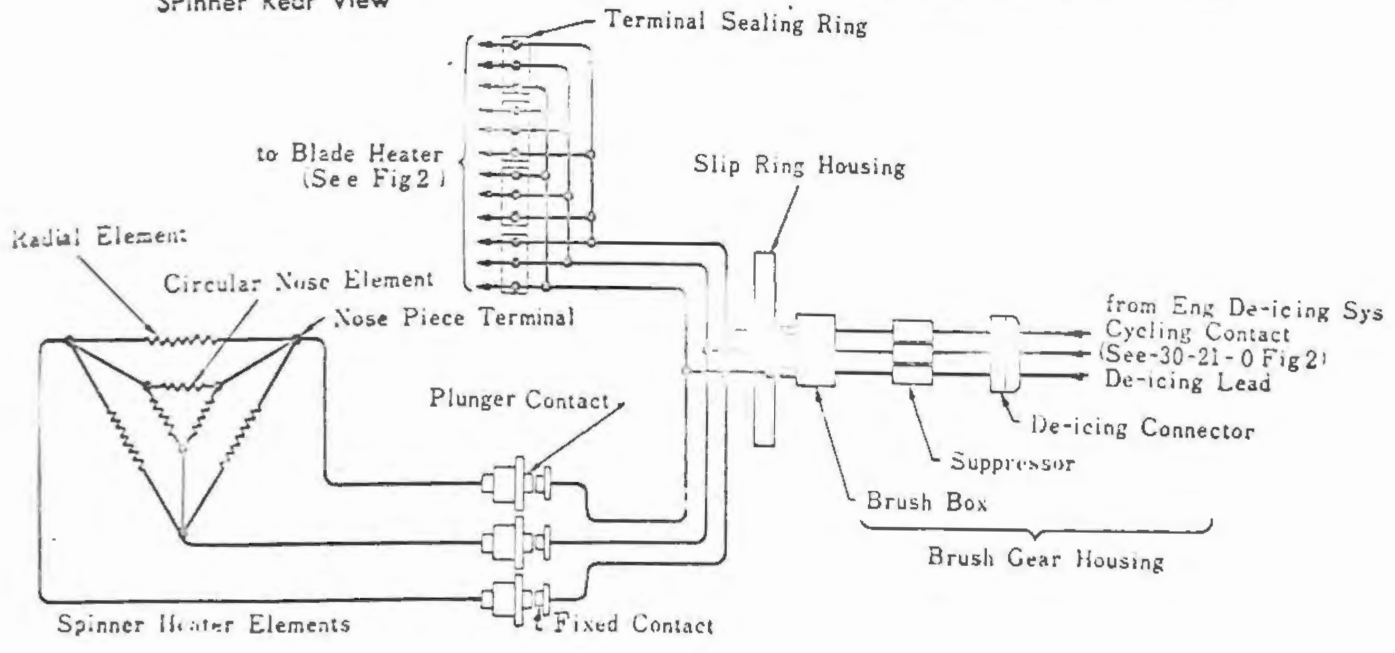
De-icing Cross-Feed
(Electric Power)

Figure 13-16



SPinner Rear View

Brush Gear Housing Front View



Propeller Spinner Anti-icing System Schematic

Figure 13-17

13.4.3 Principal Components

Part name	Station	Q'ty/Ship
Suppressor	Spinner brush gear housing	2
Brush box	"	2
Slip ring housing	Propeller	2
Terminal sealing ring	"	8
Fixed contact	"	6
Spring contact	"	6
Blade heater element	"	8
Spinner heater element	"	2

3.5 Pitot and Static Anti-Icing System

13.5.1 Outline

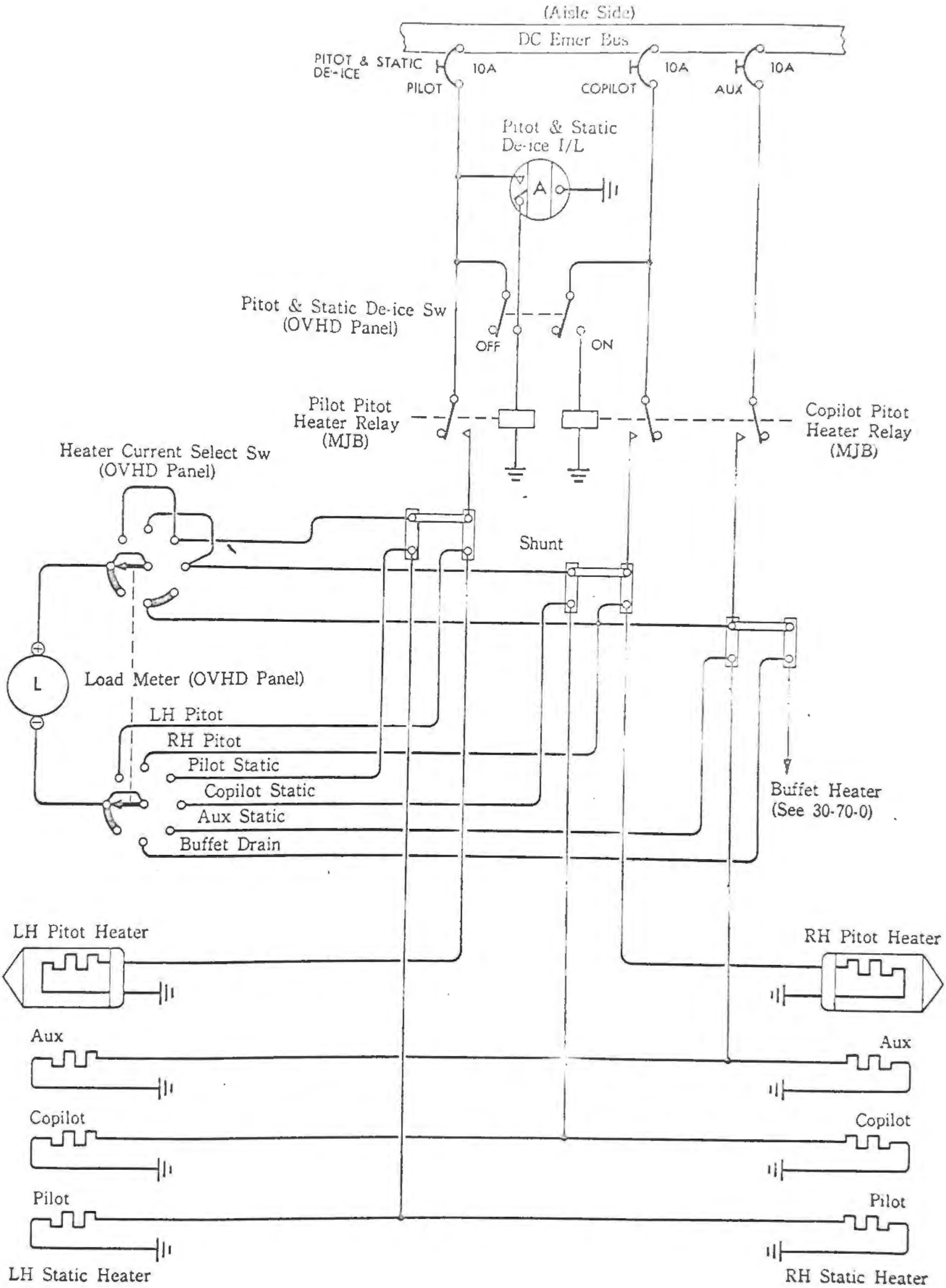
The left and right Pitot tubes contain a Pitot heater (28V 80W) one each inside for the purpose of anti-icing, and each static port has a static heater (28V 57W) for the same purpose.

Whether these heaters are functioning normally or not can be confirmed by means of the selection switch of the load meter.

13.5.2 System Operation

The power, DC 28V, is supplied from the DC emergency bus through the corresponding 10-A circuit breakers in the circuit breaker panel. When the Pitot & static de-ice switch on the overhead panel aft. is turned "ON", the Pitot & static de-ice indicator light comes on and, at the same time, the Pitot and the copilot Pitot heater relays are actuated to deliver DC power to each heater through the shunt to energize the heaters.

To this shunt is connected the load meter through the selector switch. So, the working condition of heaters can be confirmed by operating the selector switch.



Pitot & Anti-icing System Schematic
Figure 13-18

13.6 Windshield Anti-Icing System

13.6.1 Outline

This system is operated by heating uniformly the entire windshield glass with the WF power supplied to the transparent conductive film embedded throughout the entire glass area. The left and right windshield panels can be heated in two steps, "high" or "low" by operating the "windshield de-ice" select switch on the cockpit overhead aft LH panel.

The WF power is taken from the A ø and B ø phases of No. 1 bus and the B ø and C ø phases of No. 2 bus. When the select switch is placed in the "high" position, the left and right windshield panels are connected in parallel to No. 1 bus and No. 2 bus. When the switch is placed in the "low" position, the two panels are connected in series to only No. 1 bus for the supply of power. This means that the "high" connection takes four times as much power as the "low" connection. Besides, when the heater is in operation, the corresponding indicator light is on.

In this anti-icing system, when the switch is kept in its "low" position during flight, the vinyl layer on the inside wall of the glass is heated to give suitable flexibility to the glass so as to absorb the impact shocks caused by birds etc.

13.6.2 Principal Components

Part Name	Station	Q'ty/Ship
Windshield heater element	Windshield	2
Heater sensing element	"	2
Windshield de-icing indicator	Cockpit overhead panel	2
High-low selector switch	"	1
High-low transfer relay	Elect. compt.	1
De-icing control relay	"	2
De-icing power relay	"	2

13.6.3 System Operation

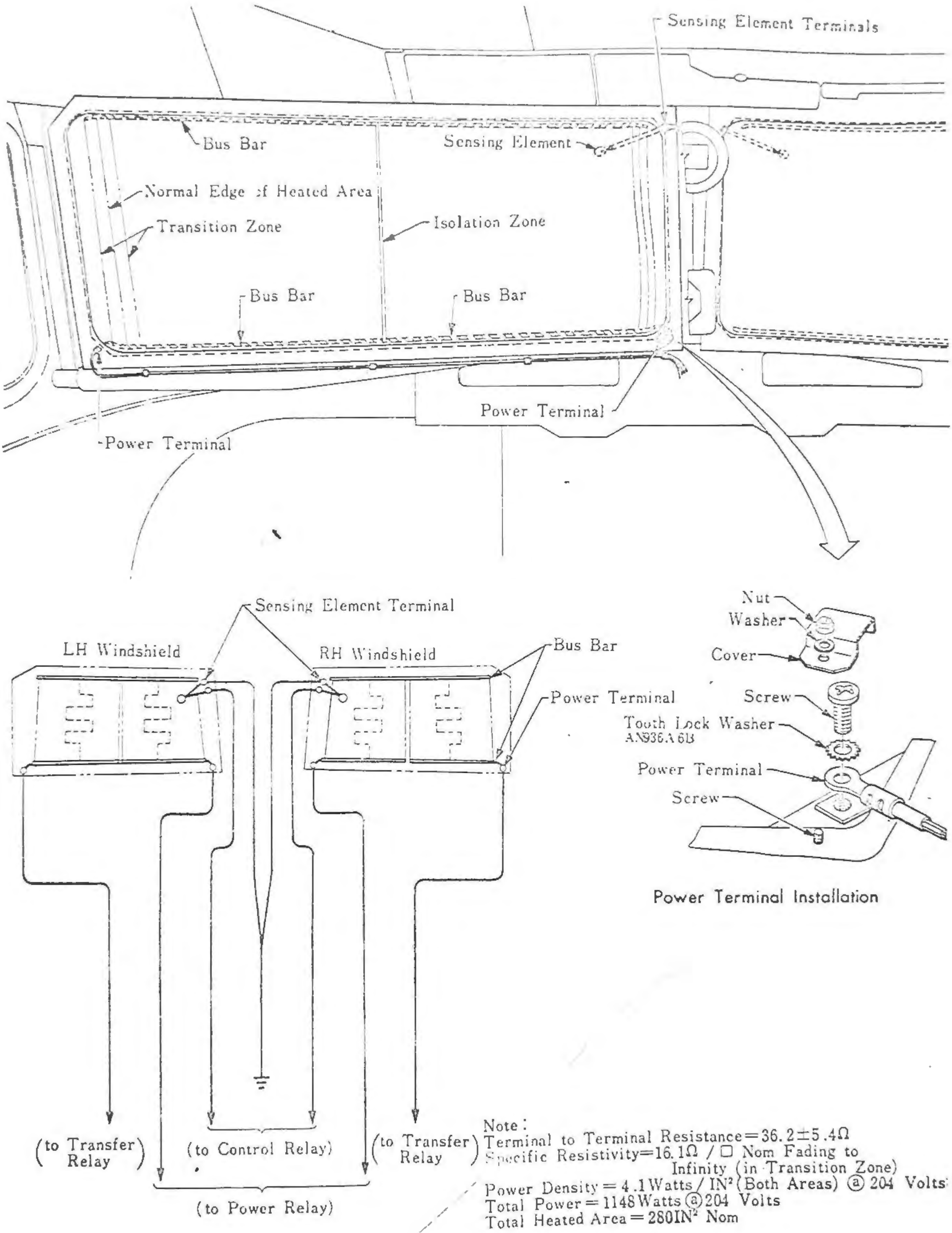
The de-icing control relay is closed by turning on the windshield de-icing select switch. Then, the de-icing power relay is energized, closing the circuit to light de-icing indicator light and, at the same time, to connect the WF power source to the heater circuit.

So, if the select switch is placed in its "low" position, the power is taken only from No. 1 bus to connect the heater elements on both panels in series.

If the switch is placed in its "high" position, the transfer relay is closed to cut off the power supply from the left side and connect the WF power to No. 2 bus, making a parallel circuit. As a consequence, the energy for the heating is supplied by the WF buses on both sides.

When the heating is in progress, the indicator lights are on. When the temperature of the panel rises to 43 ± 4°C (110 ± 7°F), the sensing element embedded in the windshield panel closes its contact to short circuit the electric current of the corresponding control relays, cutting off the control relay and opening the power relay consequently. Thus, the connection to the heating circuit is cut off.

As the panel temperature goes down and the sensing element contact is opened, the heating circuit is made to flow electric current to the heater element consequently to raise the temperature.

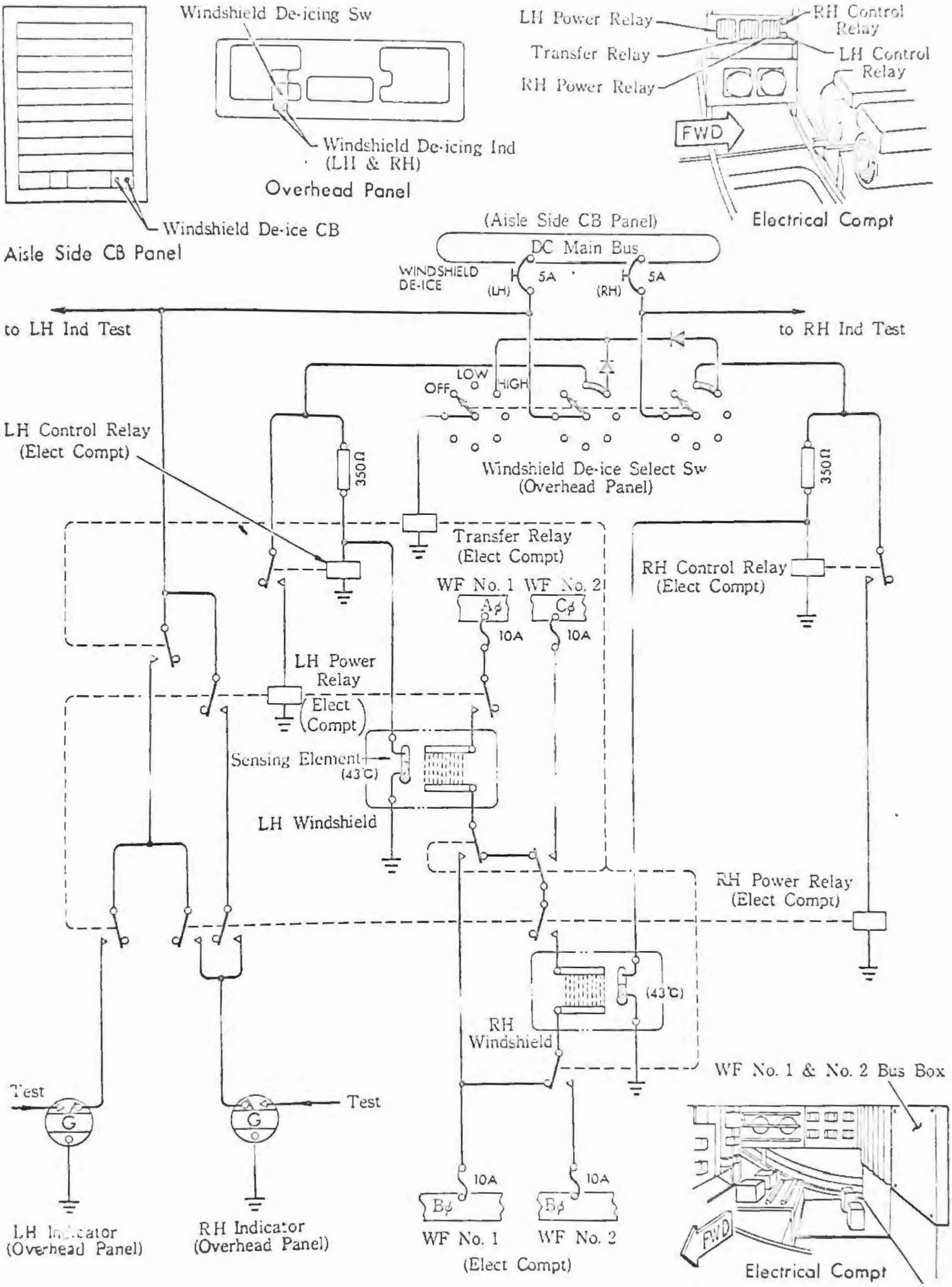


Power Terminal Installation

Note:
Terminal to Terminal Resistance = 36.2 ± 5.4Ω
Specific Resistivity = 16.1Ω / ☐ Nom Fading to Infinity (in Transition Zone)
Power Density = 4.1 Watts / IN² (Both Areas) @ 204 Volts
Total Power = 1148 Watts @ 204 Volts
Total Heated Area = 280IN² Nom

Electrical Schematic

Sierracin Glass Detail
Figure 13-19



Windshield Anti-icing System Schematic

Figure 13-20

Chapter 14 OXYGEN SYSTEM

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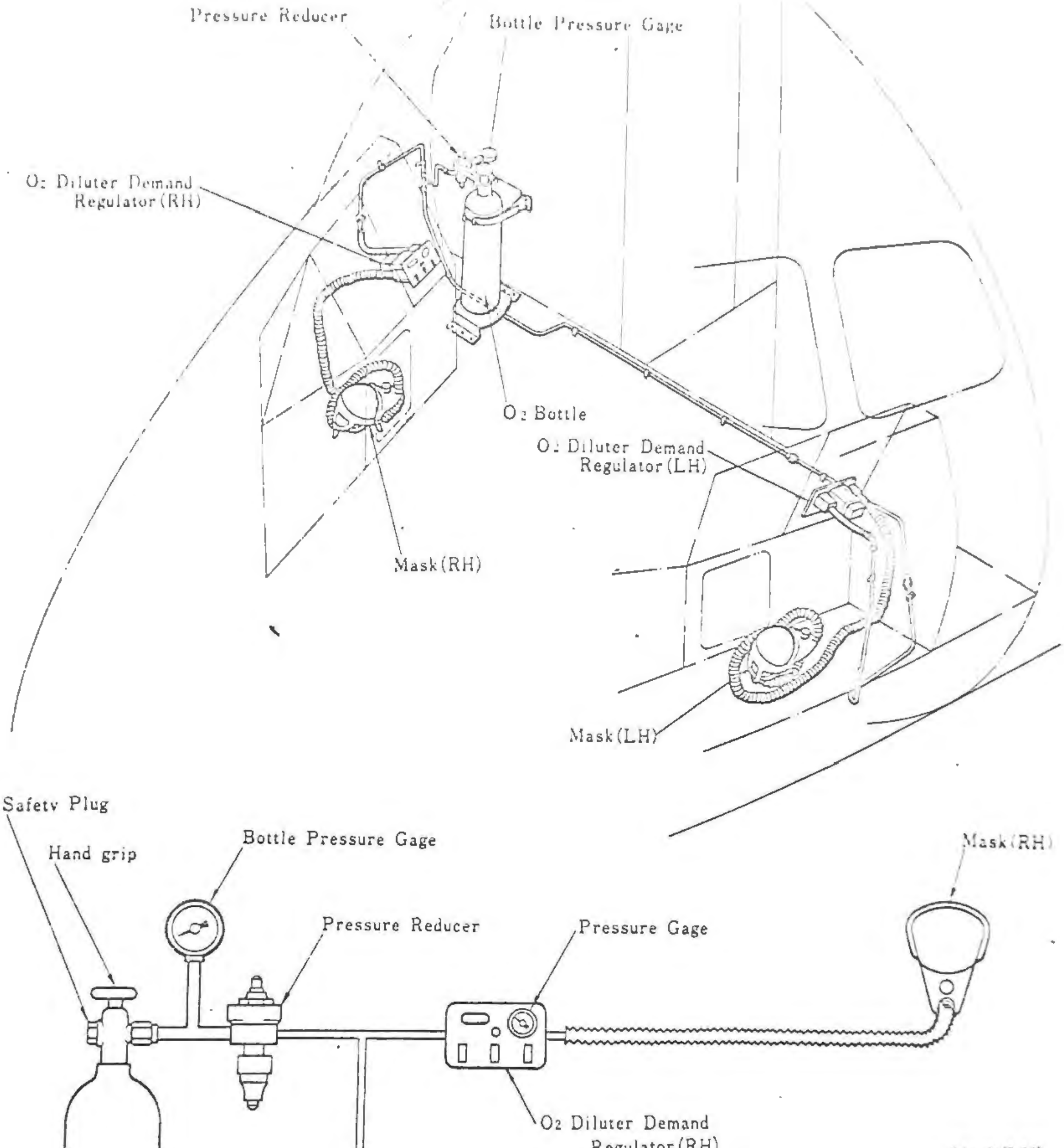
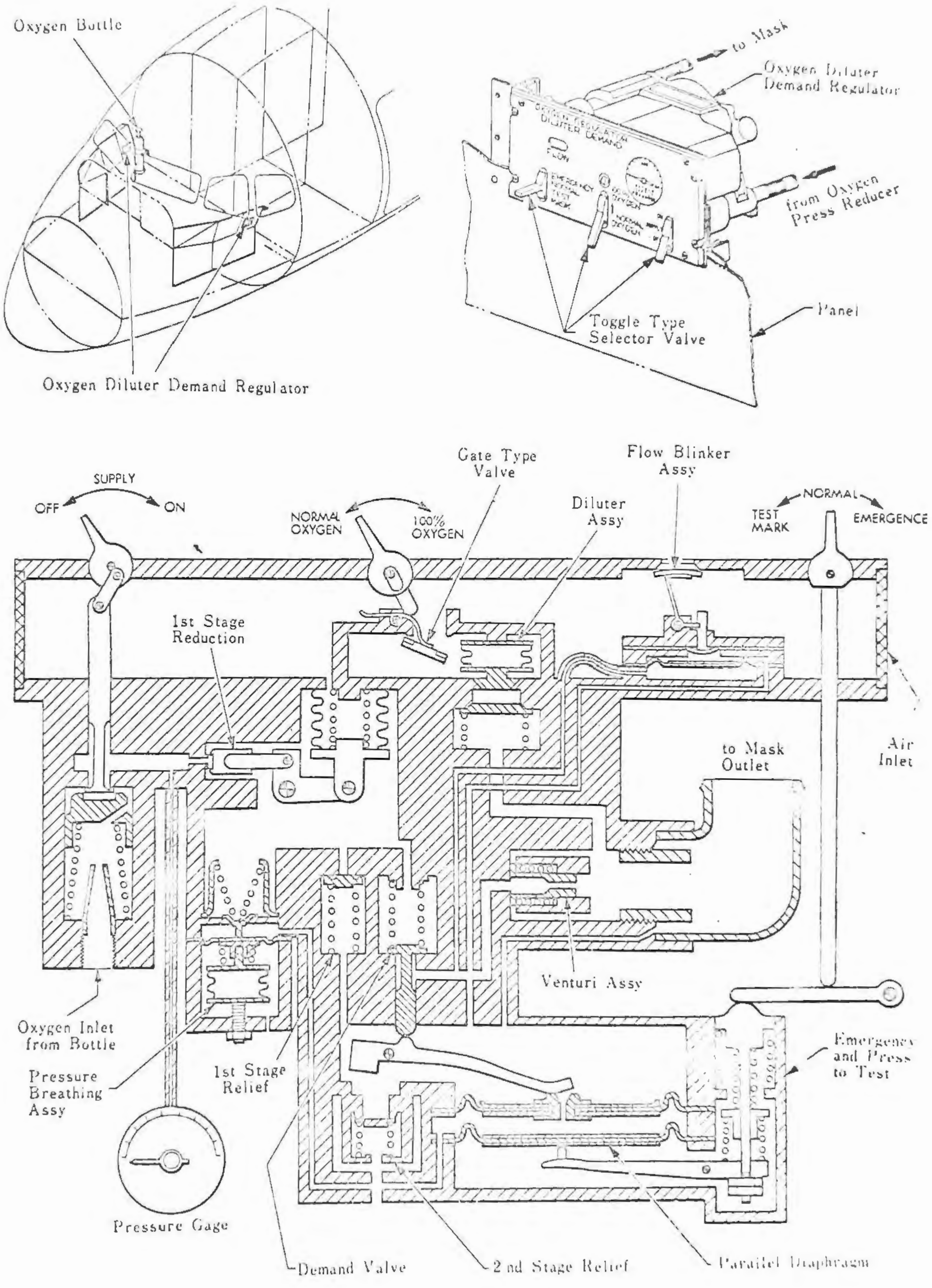
14.4 Passenger Portable Oxygen System 4



Flight Crew Oxygen System Schematic

Figure 14–1



Flight Crew Oxygen Diluter Demand Regulator

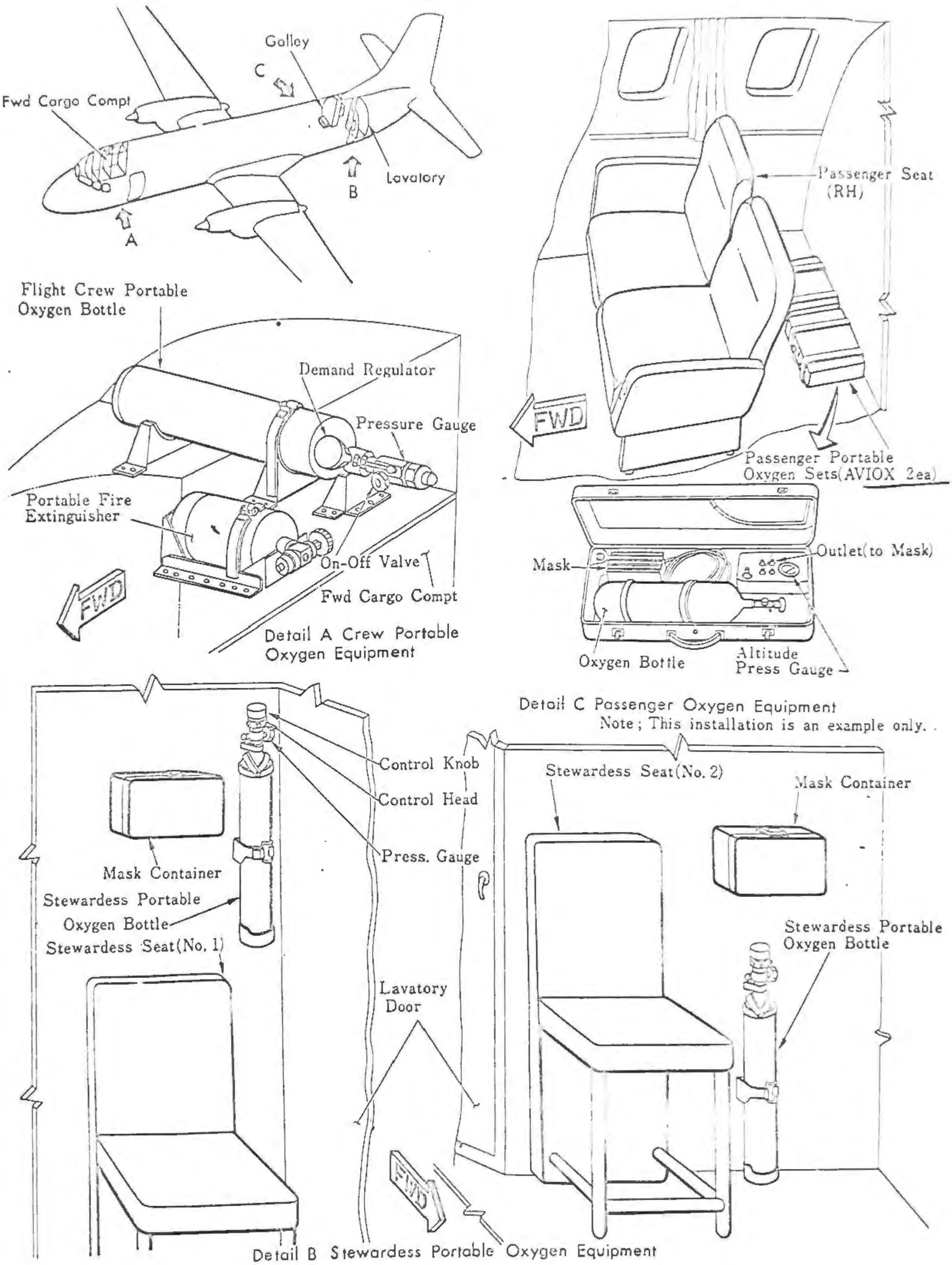
Figure 14-2

Valve position	Oxygen flow
OFF	0
Medium	2 ℓ / min
High	4 ℓ / min

14.4 Passenger Portable Oxygen System

In the rearmost part of the R.H. cabin behind the rearmost row is located a portable case with the oxygen bottle, pressure indicator and masks made of rubber contained in it which can be easily carried. The capacity is 22 cu.ft, the pressure being 1500 to 1800 psi. Duration of oxygen vs. number of persons using oxygen and altitudes is shown below.

Number of persons using oxygen	Altitude 8,000 ft	10,000 ft	12,000 ft	14,000 ft
1	9.8 hr	7.9 hr	6.5 hr	5.6 hr
2	4.9	3.9	3.2	2.8
3	3.3	2.6	2.1	1.8
4	2.4	1.9	1.6	1.4



Detail A Crew Portable Oxygen Equipment

Detail C Passenger Oxygen Equipment
Note ; This installation is an example only.

Detail B Stewardess Portable Oxygen Equipment

Portable Oxygen Installation
Figure 14-3

Chapter 15 FIRE PROTECTION SYSTEM

15.1 General

The fire protection system is provided for the safety of flight. The fire protection system consists of the detection system which notifies the pilots of fire or overheating, and the fire extinguishing system.

(1) Fire Detection System

Engine
Landing gear bay

(2) Overheat Detection System

Engine overheat
Engine cooling air overheat
Gear box overheat

(3) Fire Extinguisher

Engine (methyl-bromide)

15.2 Fire Detection System

15.2.1 General

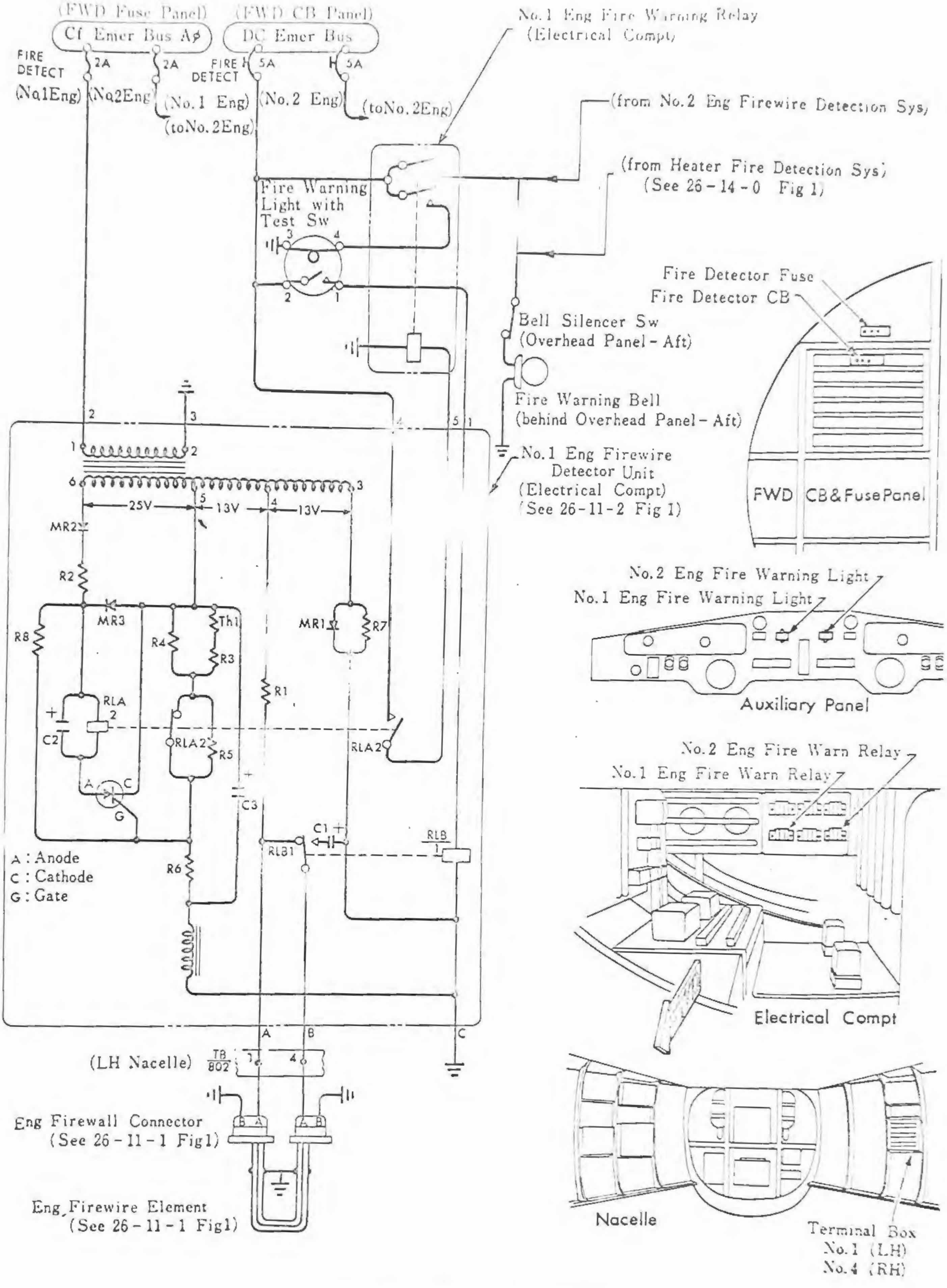
In the engine Zone 1 (engine front section) and Zone 2 (engine rear section) are provided fire wire elements around the engine in order to inform the pilots of engine fire.

The temperature rise sensed lights the fire warning light and rings the bell in the cockpit by means of the fire detector unit, to notify the pilots of the fire.

In the L.H. and R.H. landing gear bays are located the thermoswitches which come into action if the temperature rise in the bay becomes a fire hazard, lighting the warning light and ringing the bell in the cockpit to warn the pilots.

15.2.2 Engine Fire Detection System

In order to notify the pilots of engine fire, fire sensing elements are located around the engine in the engine zone I and zone II. This element, sensing the engine temperature, transmits signals to the control unit. This detection system operates on 115V, 400 c/s power. During the positive half cycle of 400 c/s power, the element charges electricity between the core wire and the outer pipe of the element and during the negative half cycle, the electricity accumulated is discharged, energizing the silicone rectifier located in the control unit. As the temperature rises, the amount of electricity accumulated increases, connecting the anode and the cathode of the silicone rectifier. Then, the RLA/Z relay


(FWD Fuse Panel)
Cf Emer Bus Aφ
(FWD CB Panel)
DC Emer Bus
FIRE DETECT
2A
2A
FIRE DETECT
5A
5A
(No.1Eng)
(No.2Eng)
(No. 1 Eng)
(toNo. 2Eng)
(No. 2 Eng)
(toNo. 2Eng)
No. 1 Eng Fire Warning Relay (Electrical Compt)
(from No. 2 Eng Firewire Detection Sys)
(from Heater Fire Detection Sys) (See 26 - 14 - 0 Fig 1)
Fire Warning Light with Test Sw
3
4
2
1
Fire Detector Fuse
Fire Detector CB
Bell Silencer Sw (Overhead Panel - Aft)
Fire Warning Bell (behind Overhead Panel - Aft)
No. 1 Eng Firewire Detector Unit (Electrical Compt) (See 26-11-2 Fig 1)
FWD CB & Fuse Panel
2
3
4
5
1
1
2
6
3
25V
5
13V
4
13V
MR2
R2
MR3
Th1
R8
R4
R3
MR1
R7
R1
RLA 2
C2
RLA2
R5
RLA2
A
C
G
C3
C1
RLB 1
RLB1
A : Anode
C : Cathode
G : Gate
R6
A
B
C
(LH Nacelle)
TB 802
1
4
Eng Firewall Connector (See 26 - 11 - 1 Fig1)
B A
A B
Eng Firewire Element (See 26 - 11 - 1 Fig1)
No. 2 Eng Fire Warning Light
No. 1 Eng Fire Warning Light
Auxiliary Panel
No. 2 Eng Fire Warn Relay
No. 1 Eng Fire Warn Relay
Electrical Compt
Nacelle
Terminal Box No. 1 (LH) No. 4 (RH)

Engine Firewire System Schematic

Figure 15-2

comes into operation, lighting the fire warning light and ringing the bell. To check this warning circuit, push the fire warning lamp, and the RLB/1 relay in the control unit is energized to put the C_1 condenser in the discharge circuit. The capacity of this C_1 condenser becomes equal to the amount of electricity accumulated by the temperature rise of the element, energizing the RLA/2 relay. The elements are provided in two kinds, long ones and short ones which are connected together with coupling nuts.

Part Number	Electrical resistance	Number used
D2370/60	10.0 to 16.5 Ohm	4
D2370/30	5.0 to 8.0 Ohm	2

Handle these elements in accordance with the following instructions:

(1) Bend the element smoothly with bending radius of 2" or 1" at the least.

(2) Install the element with clips at intervals less than 9".

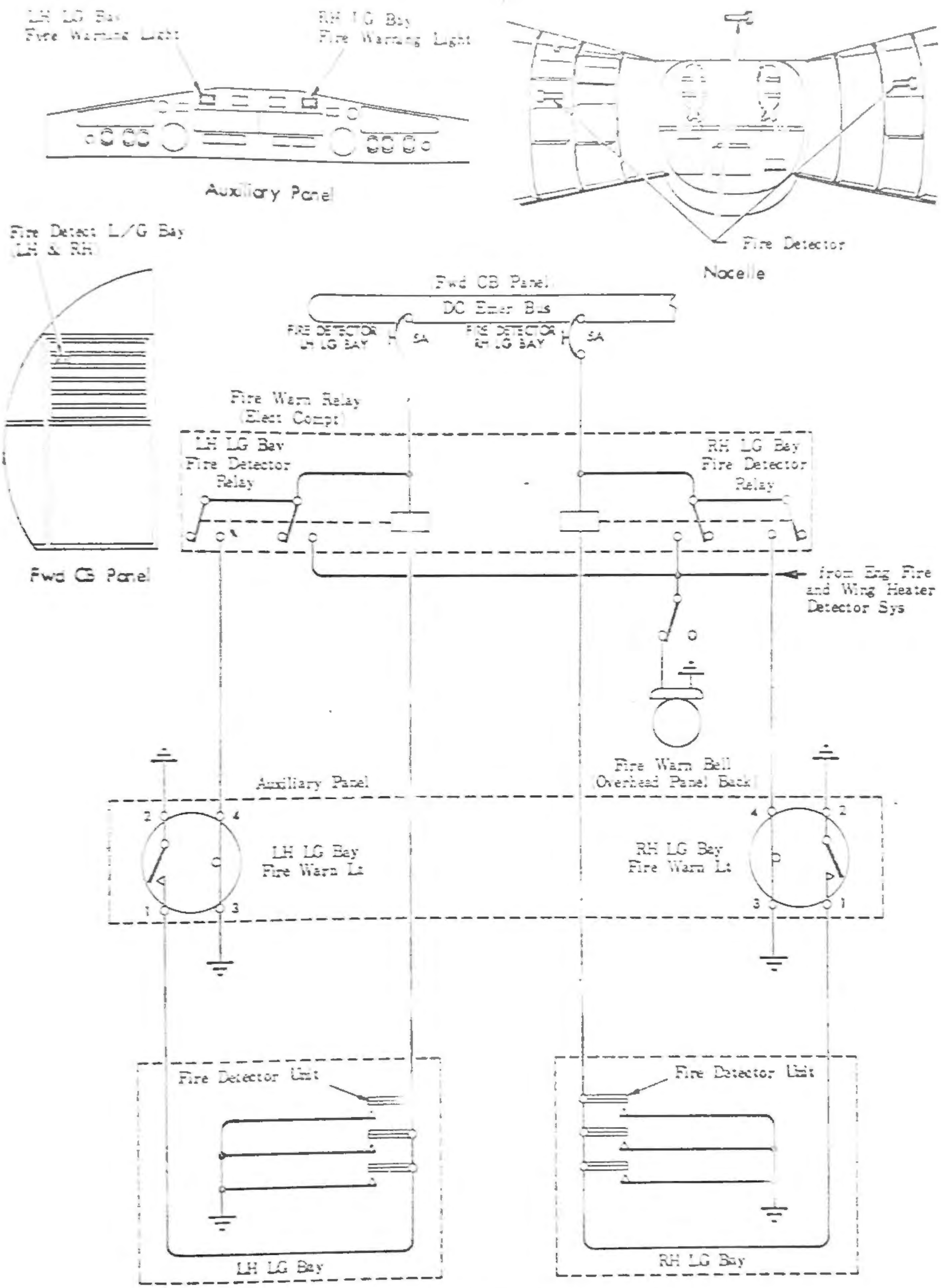
(3) Once the element is removed, use new copper sealing washer P/N D2004 when it is installed again.

(4) Tighten the coupling nut with torque of 50 to 100 in-lb.

(5) Separate the element from the engine parts by 1/4" at least to avoid false warning due to overheating of the element.

15.2.3 Landing Wheel Bay Fire Detection System

On the ceiling and the interior skin in the L.H. and R.H. landing wheel bays are provided three thermocouples come into action at 300°C. If the temperature in the landing wheel bay exceeds 300°C, the thermo switch is energized, lighting the fire warning lamp and ringing the bell.


LH LG Bay Fire Warning Light
RH LG Bay Fire Warning Light
Auxiliary Panel
Fire Detector
Nacelle
Fire Detect L/G Bay (LH & RH)
Fwd CB Panel
Fwd CB Panel
DC Emer Bus
FIRE DETECTOR LH LG BAY
5A
FIRE DETECTOR RH LG BAY
5A
Fire Warn Relay (Elect Compt)
LH LG Bay Fire Detector Relay
RH LG Bay Fire Detector Relay
from Eng Fire and Wing Heater Detector Sys
Fire Warn Bell (Overhead Panel Back)
Auxiliary Panel
2
4
LH LG Bay Fire Warn Lt
1
3
RH LG Bay Fire Warn Lt
4
2
3
1
Fire Detector Unit
LH LG Bay
Fire Detector Unit
RH LG Bay

Landing Gear Bay Fire Detector System

Figure 15-4

15.3 Overheat Detection System

15.3.1 General

This system is provided to detect overheating around the engine and gear box to warn the pilots. A system is provided to detect overheating of the H.P. turbine disc. In case of their overheating, their warning lights come on, but warning bell does not ring.

15.3.2 Engine Gear Box Overheat Warning System

Around the engine and gear box are provided thermo switches which come into action when the temperature exceeds 180°C. As the temperature rises, the overheat warning in the cockpit is lighted, warning the pilots.

The thermo switches are located:

Around the engine combustion chamber	4 ea.
In the engine breather duct	1 ea.
Around the gear box	4 ea.

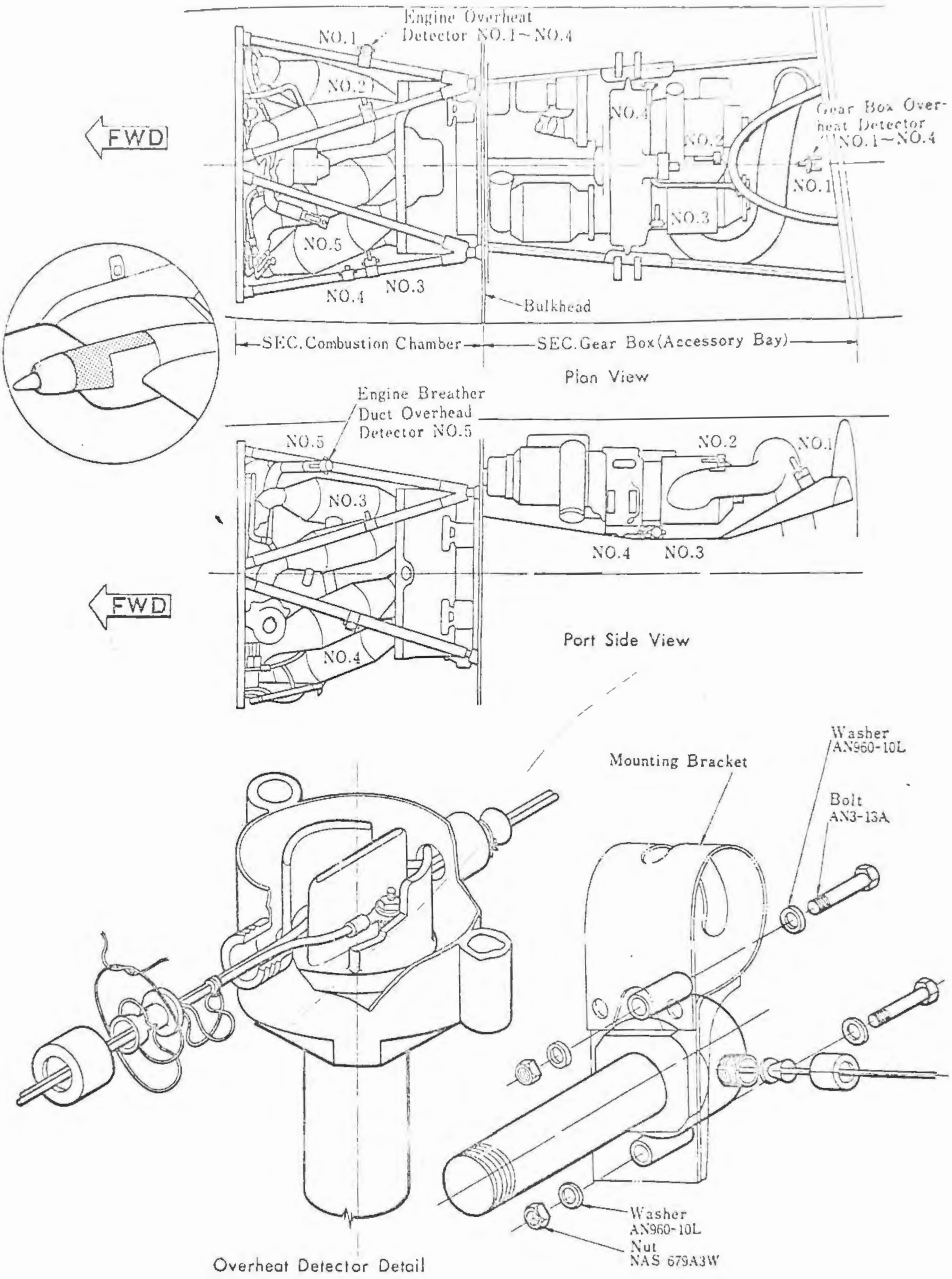
To check this circuit, push the button, and the light comes on.

15.3.3 Engine Cooling Air Overheat Warning System

On the forward surface of the engine H.P. turbine disc is provided to sense the temperature of the cooling air. The thermo couple converts the temperature of the cooling air into electrical signals for transmission.

These signals are analyzed and amplified by the warning unit located in the electrical compartment, energizing the relay and lighting the overheat warning light in the cockpit to warn the pilots.

To check this circuit, push the overheat warning light, and it should come on.



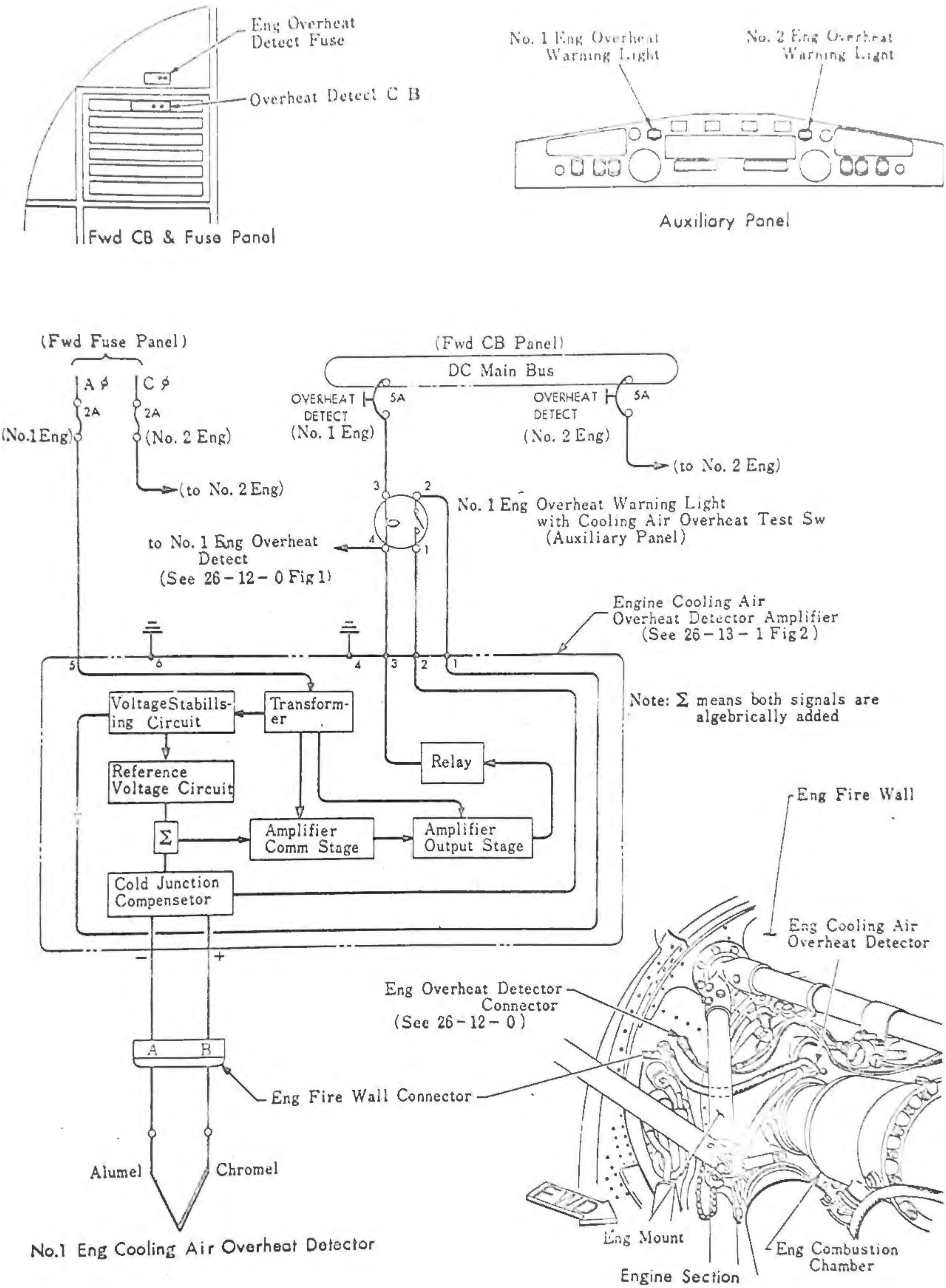
Plan View

Port Side View

Overheat Detector Detail

Engine Overheat Detector Installation

Figure 15-6


Eng Overheat Detect Fuse
Overheat Detect C B
Fwd CB & Fuse Panel
No. 1 Eng Overheat Warning Light
No. 2 Eng Overheat Warning Light
Auxiliary Panel
(Fwd Fuse Panel)
A ∅
C ∅
2A
2A
(No.1 Eng)
(No. 2 Eng)
(to No. 2 Eng)
(Fwd CB Panel)
DC Main Bus
OVERHEAT DETECT
5A
(No. 1 Eng)
OVERHEAT DETECT
5A
(No. 2 Eng)
(to No. 2 Eng)
3
2
4
1
No. 1 Eng Overheat Warning Light with Cooling Air Overheat Test Sw (Auxiliary Panel)
to No. 1 Eng Overheat Detect (See 26-12-0 Fig 1)
Engine Cooling Air Overheat Detector Amplifier (See 26-13-1 Fig 2)
5
6
4
3
2
1
Note: Σ means both signals are algebrically added
Voltage Stabilling Circuit
Transformer
Reference Voltage Circuit
Relay
Σ
Amplifier Comm Stage
Amplifier Output Stage
Cold Junction Compensetor
−
+
A
B
Eng Fire Wall Connector
Alumel
Chromel
No.1 Eng Cooling Air Overheat Detector
Eng Fire Wall
Eng Cooling Air Overheat Detector
Eng Overheat Detector Connector (See 26-12-0)
FWD
Eng Mount
Engine Section
Eng Combustion Chamber

Engine Cooling Air Overheat Warning System

Figure 15-7

15.4 Fire Extinguishing System

15.4.1 General

The methyl bromide fire extinguishing bottles are provided two each for fire fighting in the engine and the landing wheel bays. Power is supplied to them from the reserve battery through the crash bus and they can be used even if the D.C. main bus and the emergency bus are out of service.

15.4.2 Engine Fire Extinguishing System

Two methyl bromide bottles are provided independently in the landing wheel bay for each engine. Around the engine are provided a spray ring and a spray nozzle by which the pilots can extinguish fire in Zone 1 and Zone 2. Consequently, fire extinguishing agent can be discharged to one engine twice. On the exterior skin of each engine is installed a green relief indicator. To discharge the fire extinguishing agent, pull the low pressure cock handle for the engine involved, throw the guard down and place the toggle switch in "No. 1 shot" or "No. 2 shot." Then, the cartridge unit of each bottle is energized, discharging the R.H. bottle when "No. 1 shot" is selected or the L.H. bottle when "No. 2 shot" is selected.

Methyl bromide is charged in the bottle, pressurized to 250 psi (0°C) with nitrogen. Its weight is 6 lb 2 oz ± 3 oz, the total weight being 15 lb 5oz ± 4oz. It evaporates at 4°C under the normal atmospheric pressure. (#58 ~ Bromo-Chloro-DiFluoro-Methane Bottle)

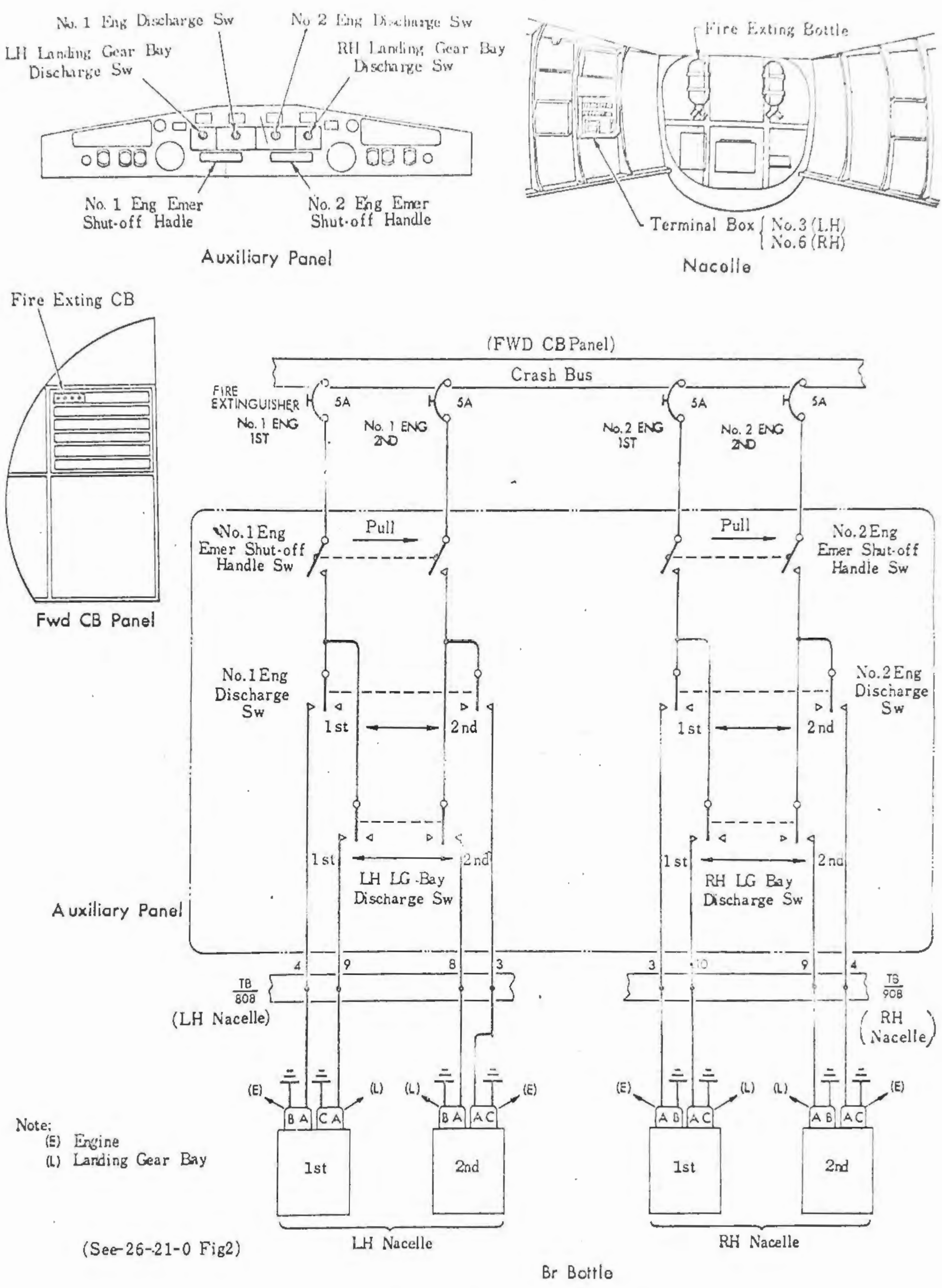
In the cartridge unit is contained a little amount of black powder which explodes when its electric circuit is made, discharging methyl bromide and popping out the indicator pin to indicate that the bottle has been discharged. If the outside temperature rises, increasing the pressure in the bottle excessively, the plug for pressure relief is ruptured and methyl bromide is discharged through the pressure discharge indicator, changing the green color of the indicator to red.

Fire extinguishing in the landing wheel bay is accomplished in the same way as that for the engine and the methyl bromide bottle is commonly used by the engine and nacelle as well. However, the fire extinguishing lines for the engine and nacelle are independently provided and consequently no cross feeding takes place.

15.4.3 Cabin Fire Extinguishing System

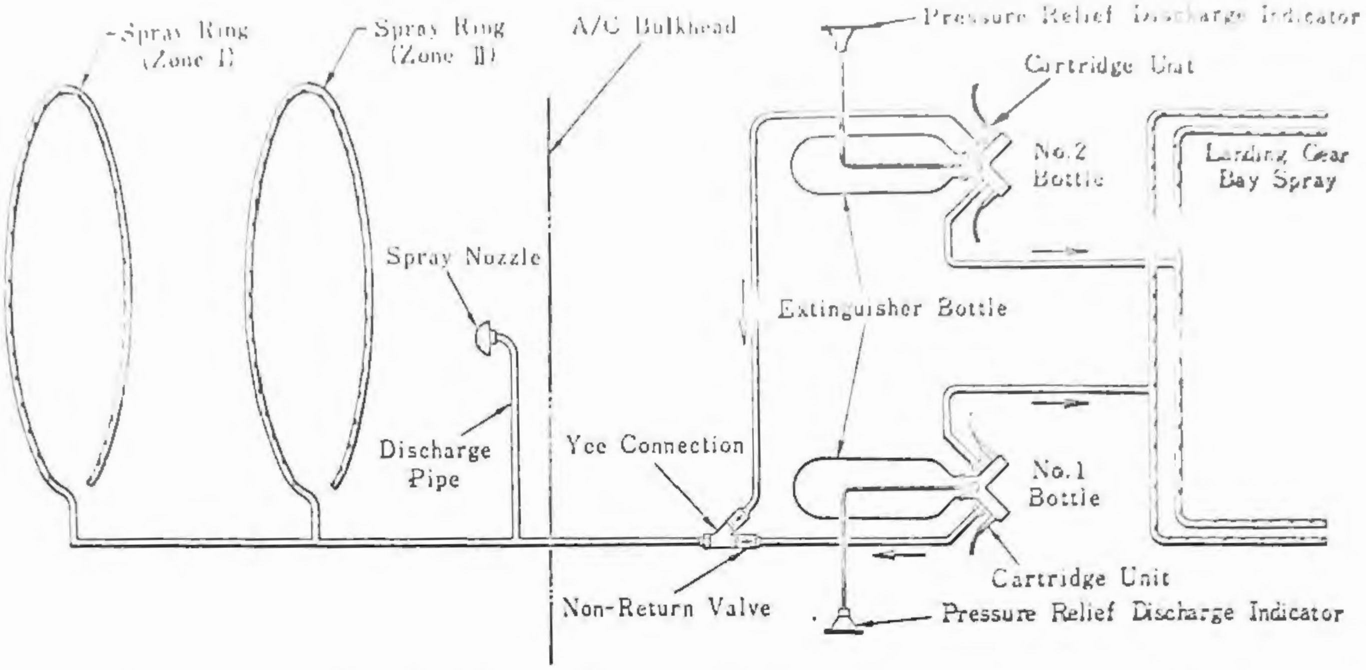
As portable fire extinguishers, freon fire extinguishing bottles are provided 1 ea. in the cockpit, on the upper shelf in the forward cargo compartment and on the wall of the aft cargo compartment by the door.

In this bottle is charged 1.21 lb of freon under 3350 psi. This agent is effectively used for fire of oil and non-toxic to human bodies. The total weight is approximately 2 Kg. When the weight is less than 1.5 Kg, recharging of the bottle is required.

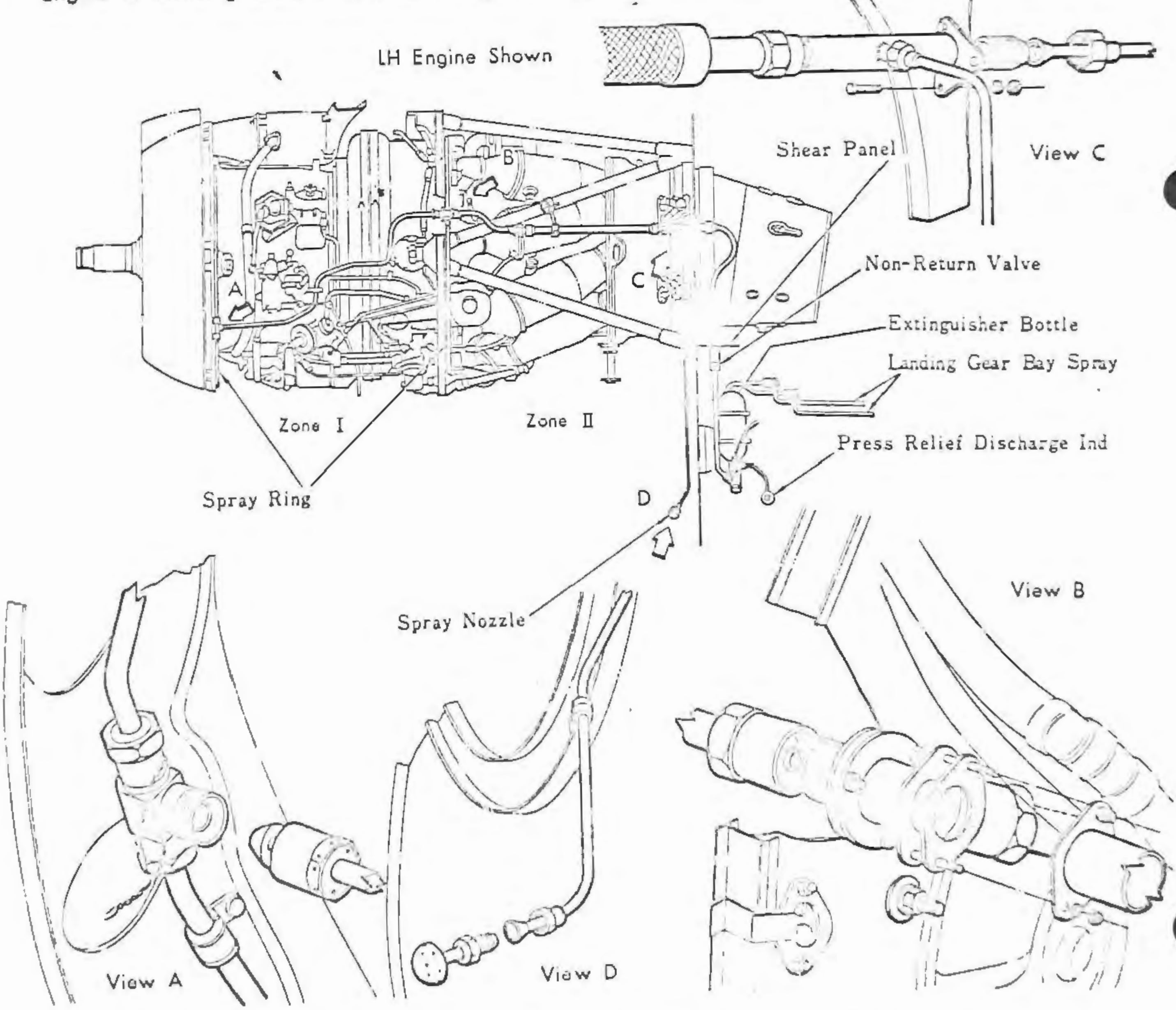


Engine Fire Extinguishing System Schematic

Figure 15-8

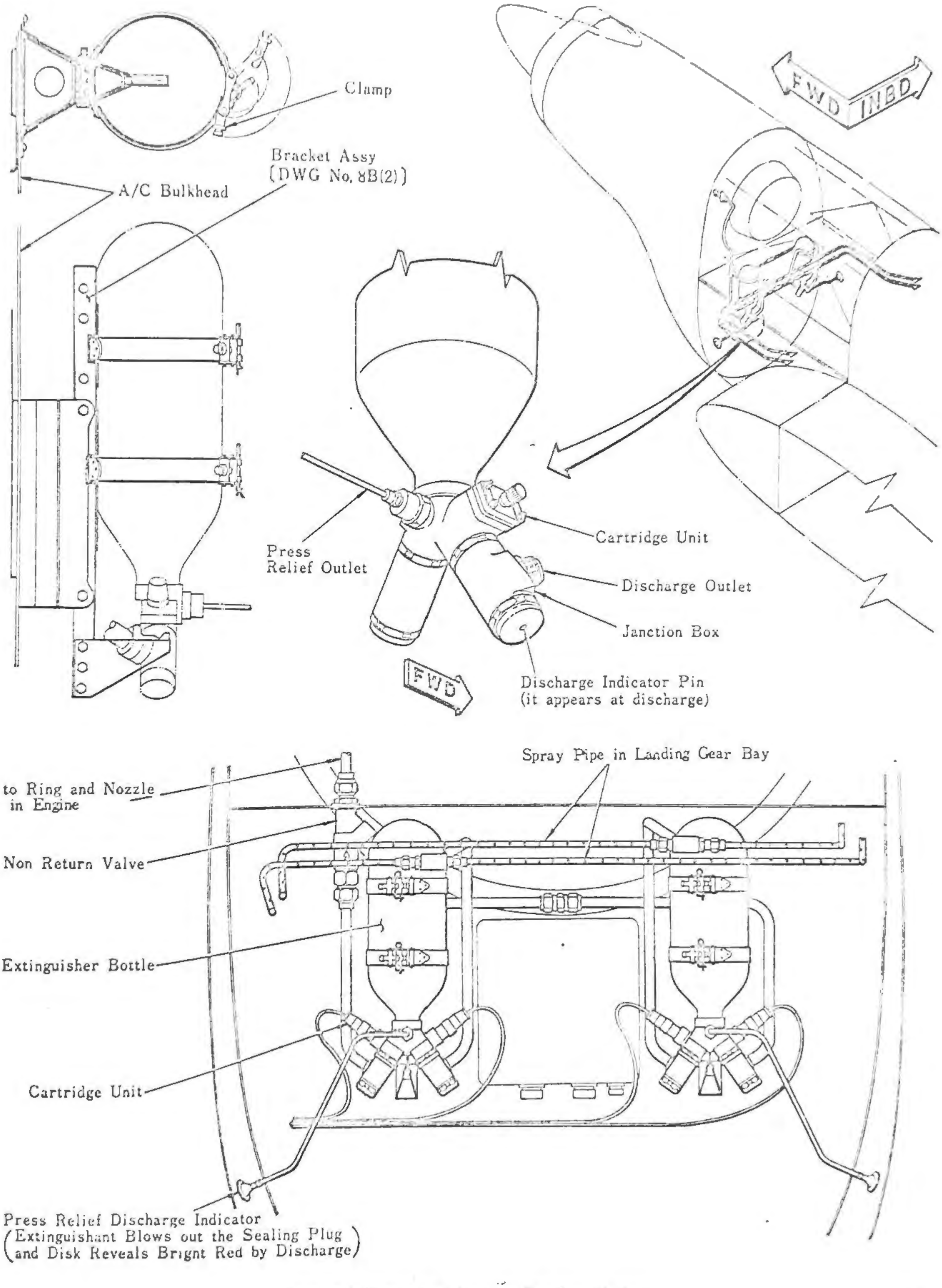


Engine & Landing Gear Bay Fire Extinguisher System Schematic



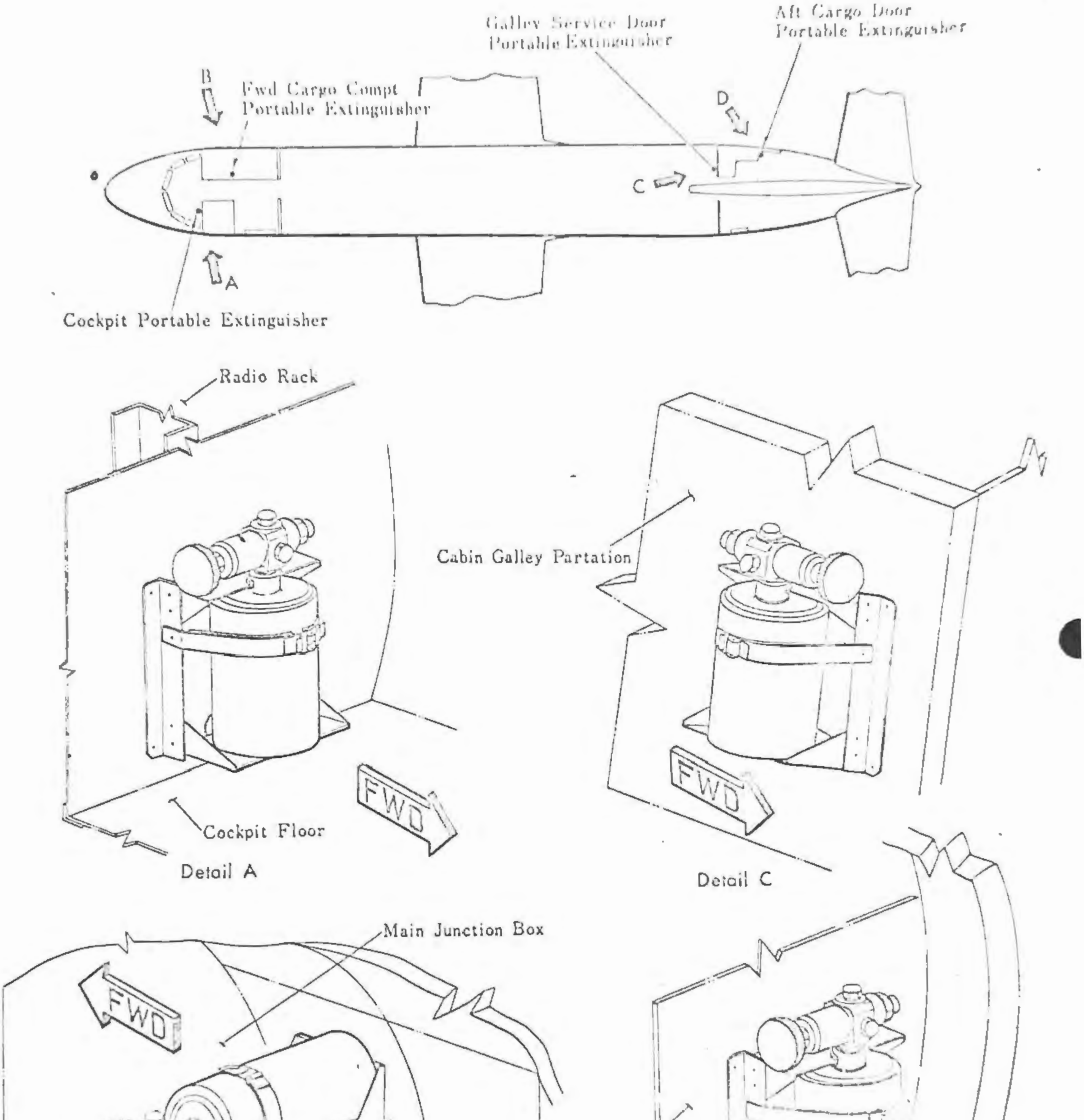
Engine Fire Extinguisher System Schematic and Spray Nozzle-Ring Installation

Figure 15-9



Bottle Indicator and Junction Box Installation

Figure 15-10



Portable Fire Extinguisher Arrangement

Figure 15-11

Chapter 16 SERVICING

16.1 Ground Equipment

The tools and equipment necessary for maintenance of the YS-11 are described here. However, equipment such as that used in component repair shops is not dealt with.

16.1.1 Flight Equipment

(1) Main Gear Safety Pin

(2) Nose Gear Safety Pin

(3) Pitot Tube Cover

(4) Forward Windshield Cover

(5) Nacelle Cover

(6) Exhaust Pipe Cover

(7) Engine Air Intake Cover

(8) Oil Cooler Cover

(9) Aileron Clamp

(10) Potable Water Replenishing Hand Pump

16.1.2 Service Equipment

(1) Towing Bar

(2) Main Wheel Chock

(3) Main Wheel Jack

(4) Nose Wheel Jack

(5) Main Jack Pad

(6) Nose Jack Pad

(7) Outer Wing Lifting Sling

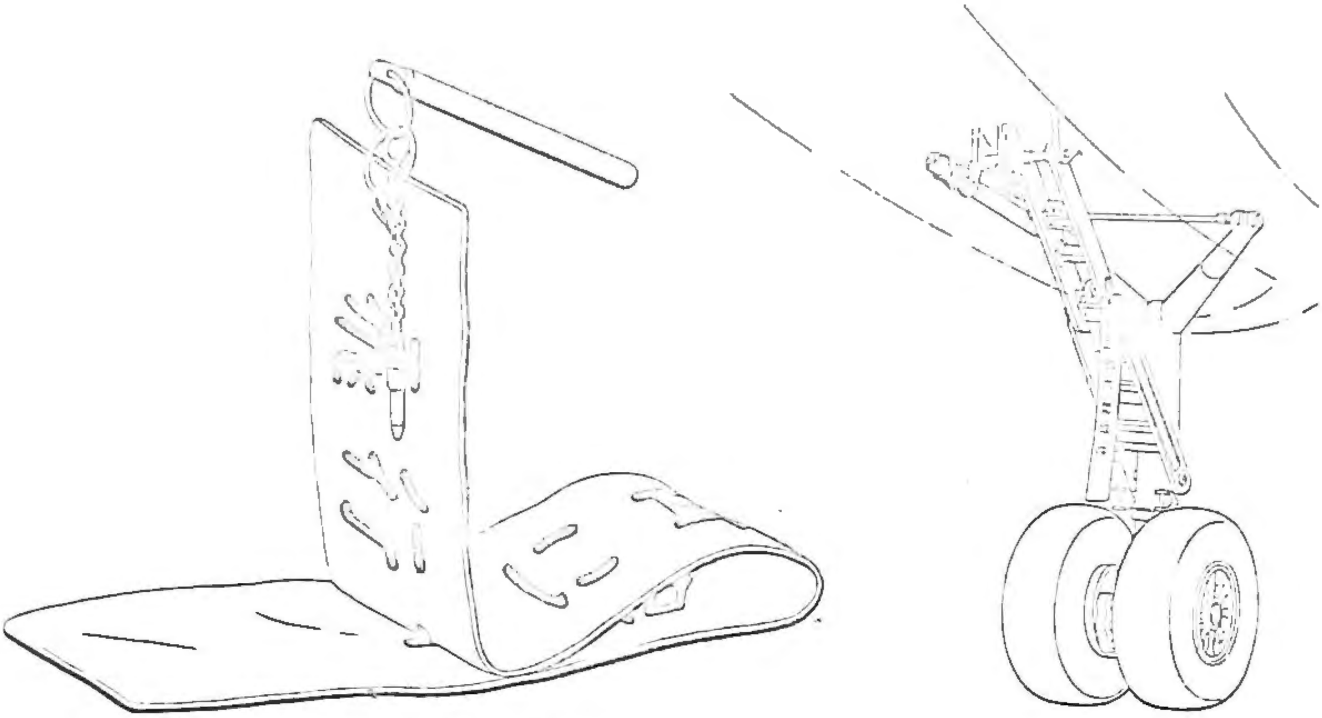
(8) Vertical Tail Lifting Sling

(9) Horizontal Tail Lifting Sling

(10) Tail Stand

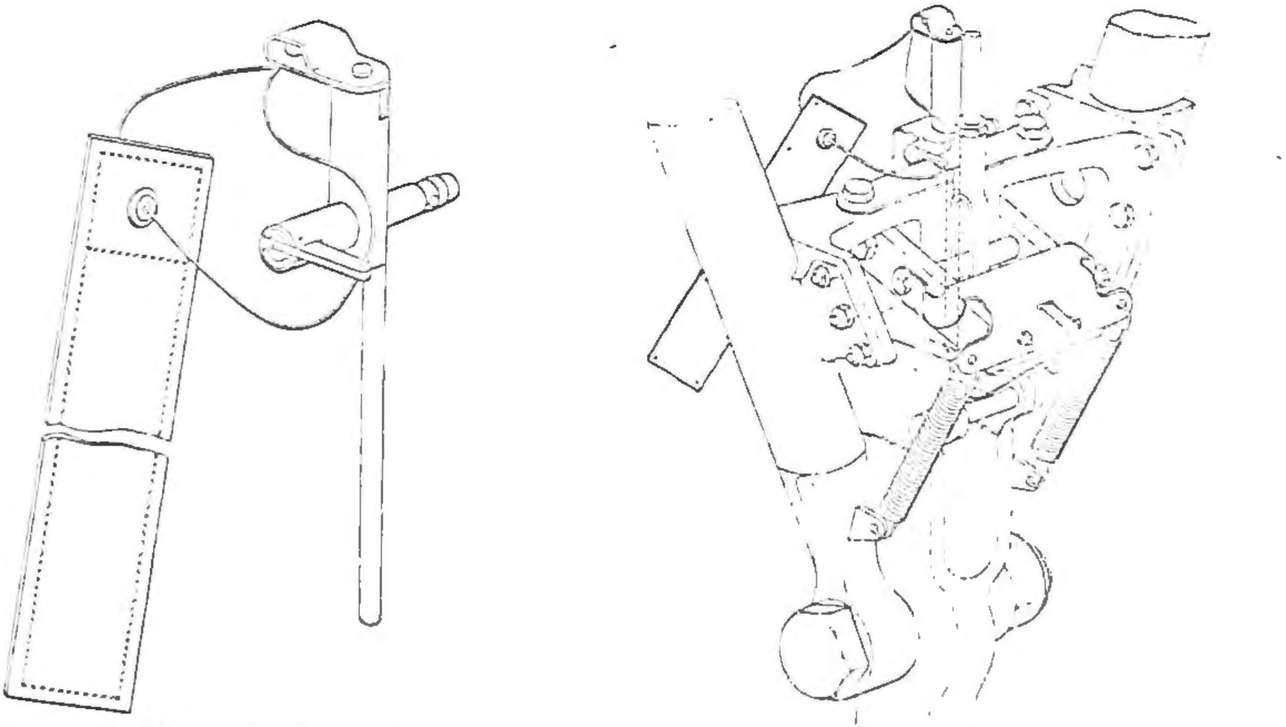
(11) Engine Sling

01-96201 Main Landing Gear Ground Lock Pin (Safety Pin)
USE: To lock the main landing gear during parking to prevent unintentional retraction.



"REMOVE BEFORE FLIGHT"

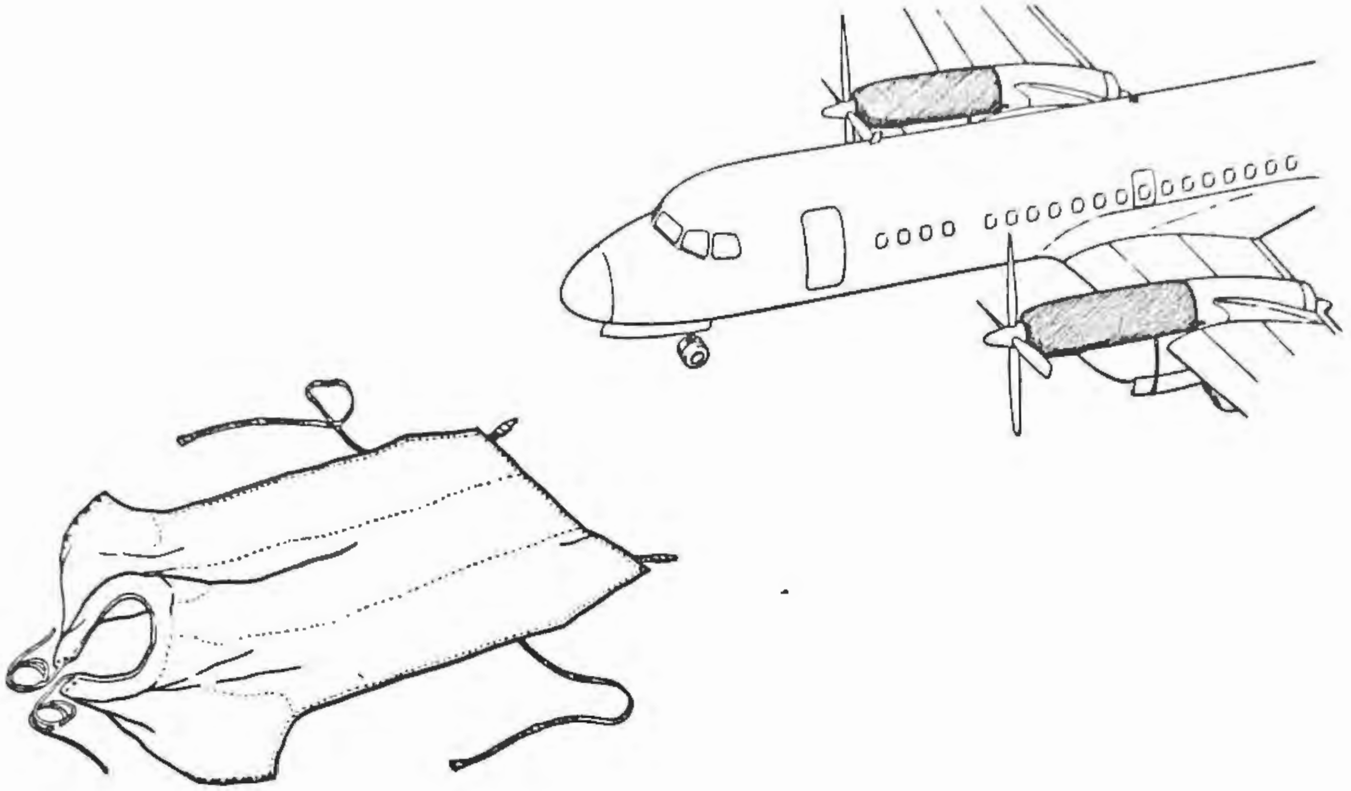
01-96005 Nose Landing Gear Ground Lock Pin (Safety Pin)
USE: To lock the nose landing gear during parking to prevent unintentional retraction.



"REMOVE BEFORE FLIGHT"

Figure 16–1

01-96247 Nacelle and Cowling Cover
USE. To protect the nacelle and cowling against entering of moisture when the aircraft is parked.



01-96213 Exhaust Pipe Cover
USE: To protect the engine against moisture and foreign matter entering through jet pipe when the aircraft is parked.

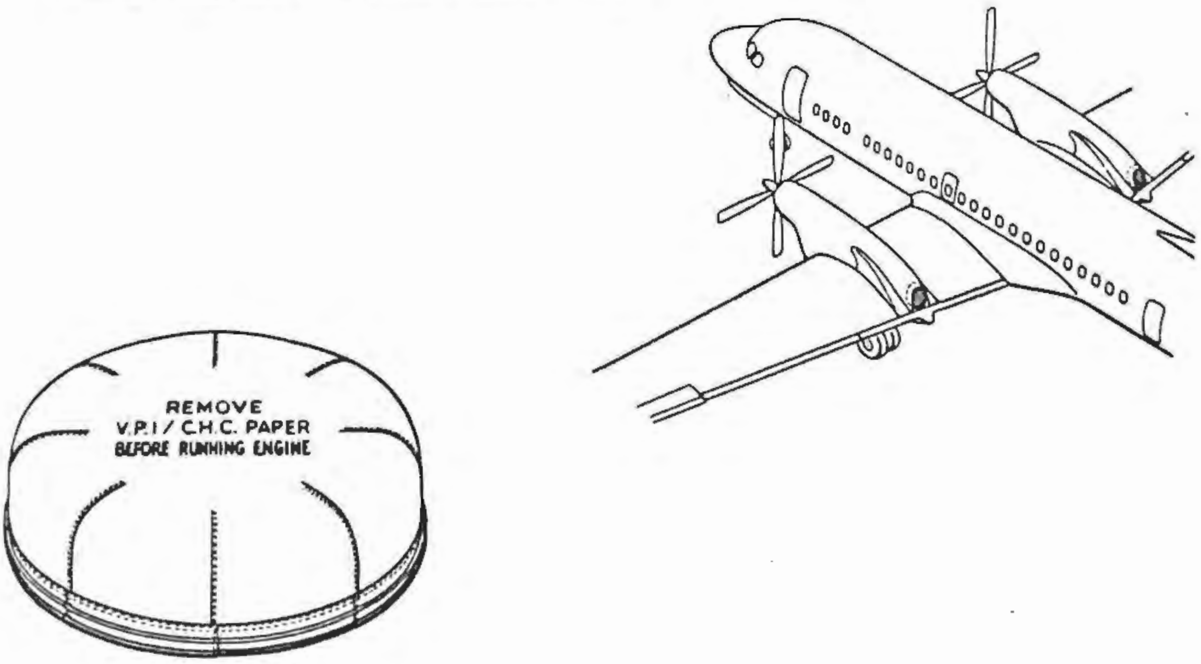


Figure 16–3

too small. As this stop is indispensable in the event of a trouble with the engine, propeller, or control unit, it will be inconvenient if it works at the time of propeller pitch fining in ordinary flight. Accordingly when the propeller pitch is fined down, the stop is designed to be automatically or manually withdrawn.

5.3.2.1 Automatic Withdrawal

For automatic control of this high stop, a hub switch is provided at the pitch angle of 29.5°. When the both propeller pitches are fined down from the cruising pitch to less than 29.5° and the hub switch is depressed "ON," the high stop withdrawal solenoid circuit is completed. When the right and left P.C.U. solenoids are excited, the oil is passed to the fine pitch relief valve to overcome the 230 psi pressure, moving the increase pressure valve to withdraw the high stop.
If the hub switch at the pitch angle of 29.5° of one propeller only is operated, the high stop withdrawal solenoid circuit is not formed; and consequently both high stops can not be withdrawn.
The hub switch remains "ON" within the range from the pitch angle of 29.5° to the ground fine pitch of 0°, and also in the feather position. This is for the purpose that even when one engine is feathered, the other engine can be controlled below the high stop.

5.3.2.2 Stop Position Indicator Light (High Stop Remove Light)

Each propeller is provided with a high stop position indicator light, which is operated by means of the oil pressure switch at the propeller control unit. The pressure switch lamp is lighted with hydraulic pressure to indicate that the high stop is in the withdrawn position, when the fine pitch relief valve plunger is operating.

5.3.2.3 Propeller Position Indicator Light (High Stop Unsafe Light)

This indicator light is a propeller light which comes on when its circuit is completed in the high stop withdrawal solenoid circuit. It operates when the propeller pitch angle decreases below 29.5°; that is, the lamp comes on when the hub switch located at the pitch angle of 29.5° of either propeller is "ON."
Usually, when the pitch is fined down from cruising, the lamp comes on and successively the two high stop remove lights are lighted, showing that the high stop is in the withdrawn position.

5.3.2.4 Propeller Emergency Switch

In case that there will be any inconvenience if the high stop be withdrawn of itself for some reason or other, or where the high stop will not be able to be formed owing to an electrical trouble with the high stop withdrawal solenoid circuit, this propeller emergency switch is used to form the high stop to prevent it from withdrawing.
This switch is located in the cockpit and has two positions: "Normal" and "Emergency." Push the switch down to "Emergency," and the high stop withdrawal solenoid is isolated, which, therefore, will not be excited and the high stop will not be withdrawn even when the right and left hub switches are set "ON."

Chapter 14 OXYGEN SYSTEM

14.1 General

The oxygen system consists of the flight crew fixed oxygen system, flight crew portable oxygen system and passenger portable oxygen system.

14.2 Flight Crew Fixed Oxygen System

The flight crew fixed oxygen system is provided for the pilot and copilot and oxygen is supplied to them when its supply is required.

The oxygen bottle contains 22 cu.ft oxygen at the room temperature under a pressure between 1500 and 1800 psi. The oxygen bottles are located on the wall behind the copilot. The demand regulators and masks are installed on the L.H. and R.H. side panels.

If the valve of the oxygen bottle is opened when oxygen is needed, the oxygen pressure is reduced to 55 ± 3 psi by means of the pressure regulator and oxygen reaches the demand regulator. Here, it is mixed with air and fed to the masks with which it can be used by the pilots. The demand regulator reduces the oxygen pressure to 30 psi and sends a quantity of oxygen or 100% oxygen corresponding to a given altitude to the masks.

If the pressure is found below 1500 psi, the bottle shall be replaced by new one.

On each mask are provided a microphone and connection plug.

14.3 Flight Crew Portable Oxygen System

The portable oxygen bottles for the pilots are installed on the shelf in the forward cargo compartment and those for the stewardesses are provided 1 ea. beside the stewardess seats.

(1) Portable Oxygen for pilots

The bottle contains 310ℓ of oxygen at a high pressure of 1800 psi and the pressure of oxygen is reduced to 55 psi.

Beside the bottle are provided the demand regulator and mask. The bottle shall be replaced by new one if its pressure is found below 1500 psi.

(2) Portable Oxygen for stewardesses

The bottle contains 120ℓ of oxygen at a pressure of 1800 psi, and is located 1 ea. beside the stewardess seats. On the head of the bottle is provided a control knob by means of which the quantity of oxygen can be varied in three steps.

Chapter 16 SERVICING

16.1 Ground Equipment

The tools and equipment necessary for maintenance of the YS-11 are described here. However, equipment such as that used in component repair shops is not dealt with.

16.1.1 Flight Equipment

(1) Main Gear Safety Pin

(2) Nose Gear Safety Pin

(3) Pitot Tube Cover

(4) Forward Windshield Cover

(5) Nacelle Cover

(6) Exhaust Pipe Cover

(7) Engine Air Intake Cover

(8) Oil Cooler Cover

(9) Aileron Clamp

(10) Potable Water Replenishing Hand Pump

16.1.2 Service Equipment

(1) Towing Bar

(2) Main Wheel Chock

(3) Main Wheel Jack

(4) Nose Wheel Jack

(5) Main Jack Pad

(6) Nose Jack Pad

(7) Outer Wing Lifting Sling

(8) Vertical Tail Lifting Sling

(9) Horizontal Tail Lifting Sling

(10) Tail Stand

(11) Engine Sling

(12) [illegible] Sling

(13) Work Step

(14) Control Surface Balancing Stand

(15) Propeller Dolly

(16) Tail Pipe Stand

(17) Engine Dolly

(18) Air Charger

(19) Tug Truck

(20) Ground Power Unit

(21) Water Replenishing Cart

(22) Filthy Water Disposal Cart

(23) Fuel Lorry

(24) Hydraulic Test Stand

16.1.3 Special Equipment

(1) Rig Pins

a. Aileron Control
b. Aileron Trim Tab
c. Elevator Trim Tab
d. Rudder Control
e. Rudder Spring Tab
f. Flap Asymmetry Detector
g. Gust Lock
h. Normal Brake
i. Emergency Brake
j. Landing Gear
k. Emergency Down
l. Steering
m. Throttle Control
n. HPC Control

(2) Rigging Tools

a. Control Wheel
b. Control Column
c. Gust Lock Sector

(3) Check Gauges

    a. Aileron
    b. Elevator
    c. Rudder
    d. Flap

(4) Wrench, Adapter, Brake

(5) Wrench, Adapter, Landing Gear

(6) Wrench, Adapter, Outer Wing

(7) Locking Plate, Corrector Motor

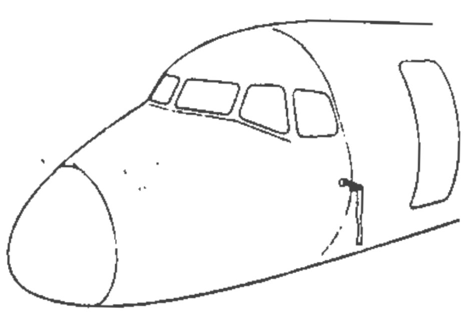
(8) Propeller Maintenance Tools

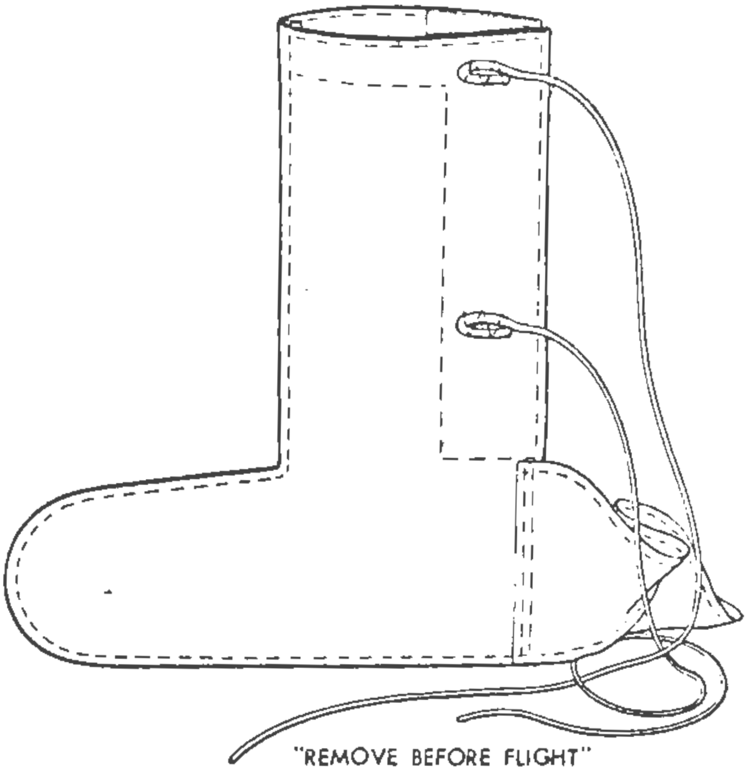
(9) Engine Tools

01-96056-11 Pitot Tube Cover LH

01-96056-12 Pitot Tube Cover RH

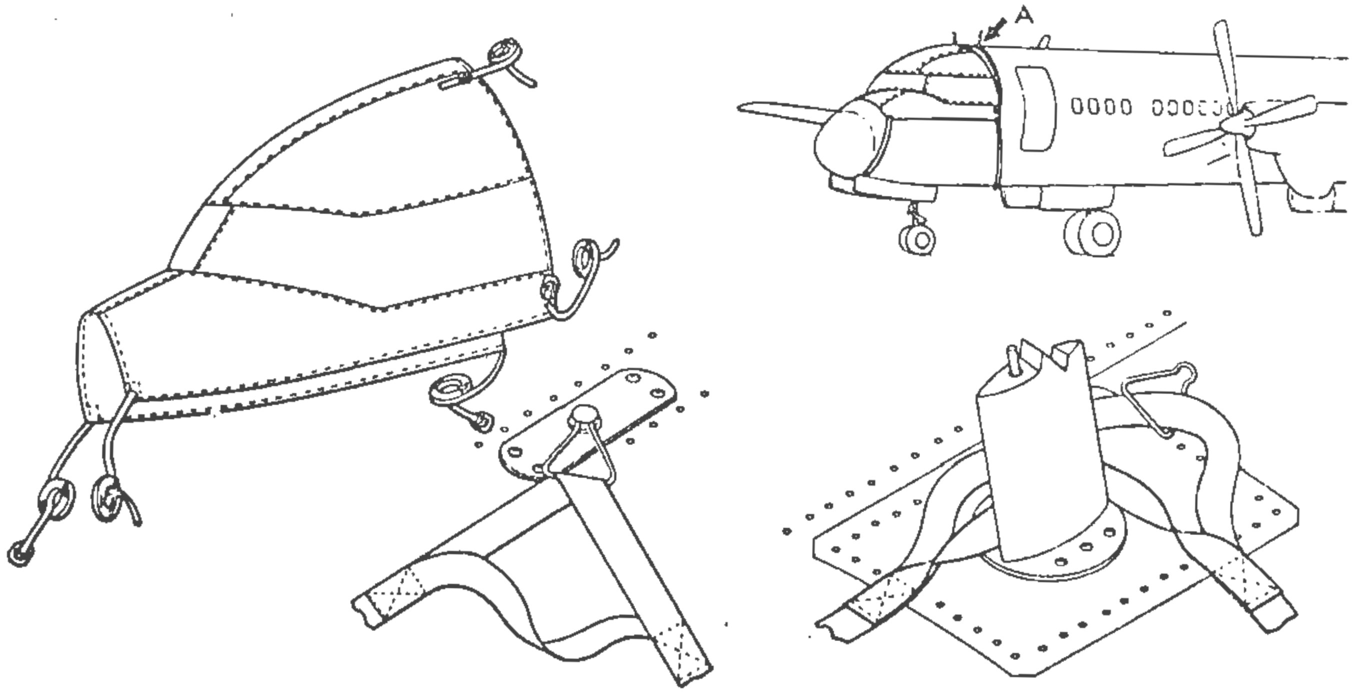
USE: To prevent dirt and moisture from entering the pitot tube and static slots. While the aircraft is parked.





01-96051 Cockpit Cover

USE: To protect the foward wind shield and side window while the aircraft is parked.



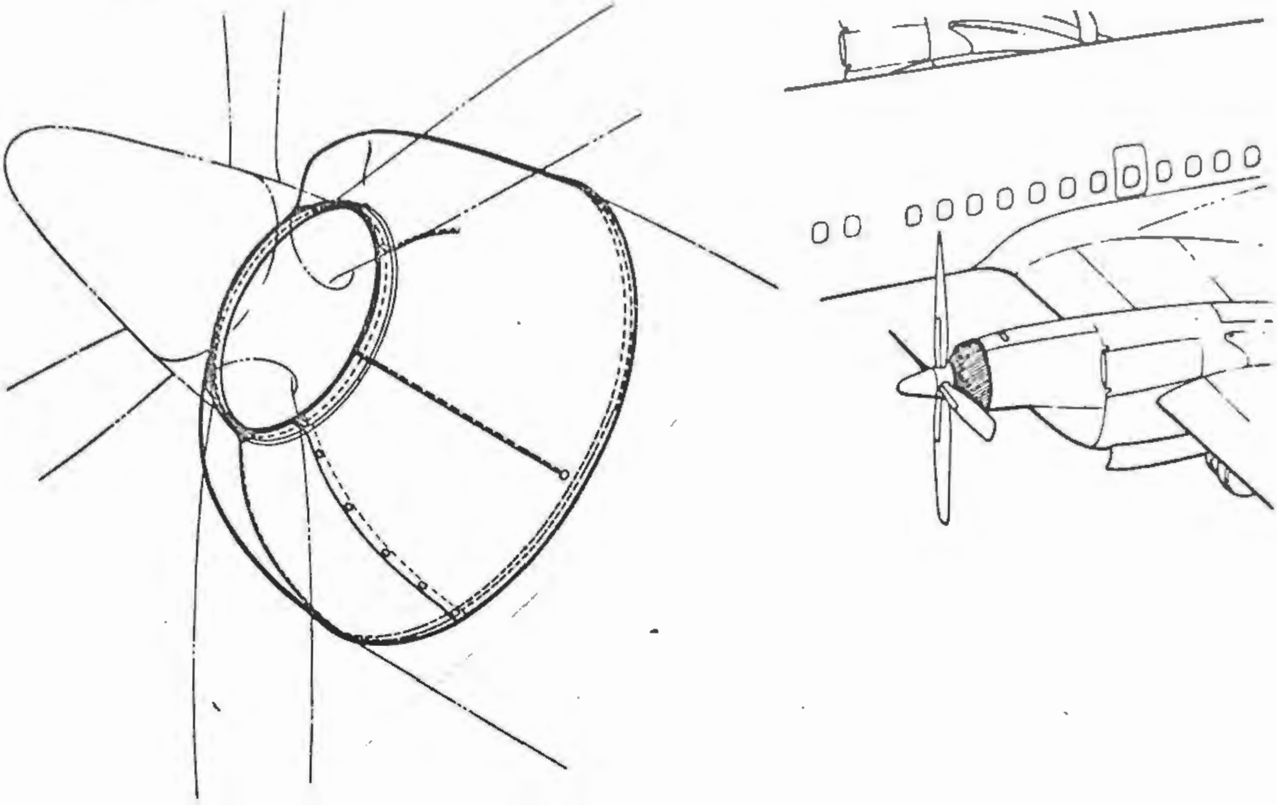
Without HF Antenna

With HF Antenna

Figure 16–2

01 96209 Engine Air Intake Cover

USE; To protect the engine air intake against entering of moisture when the aircraft is parked.



01-96257 Oil Cooler Outlet Cover (Cap)

USE; To protect the engine against entering of moisture and foreign matter through the oil cooler outlet while the aircraft is parked.

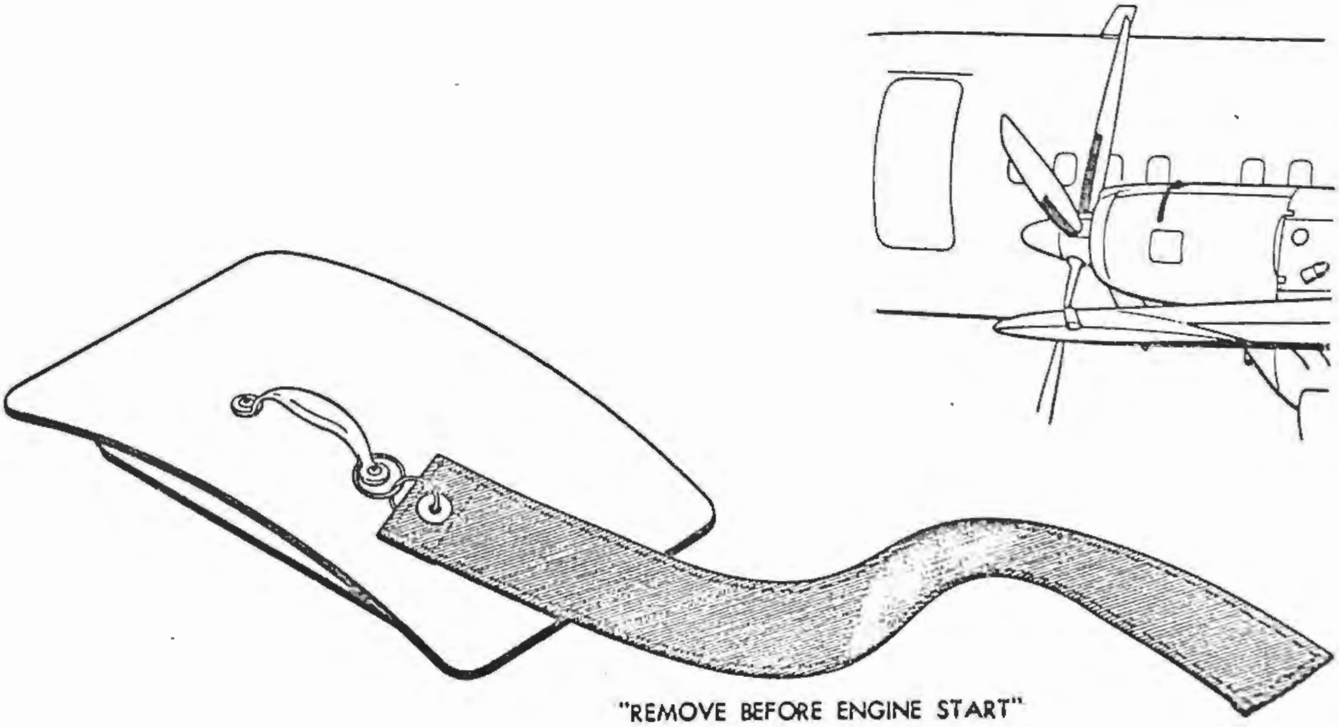
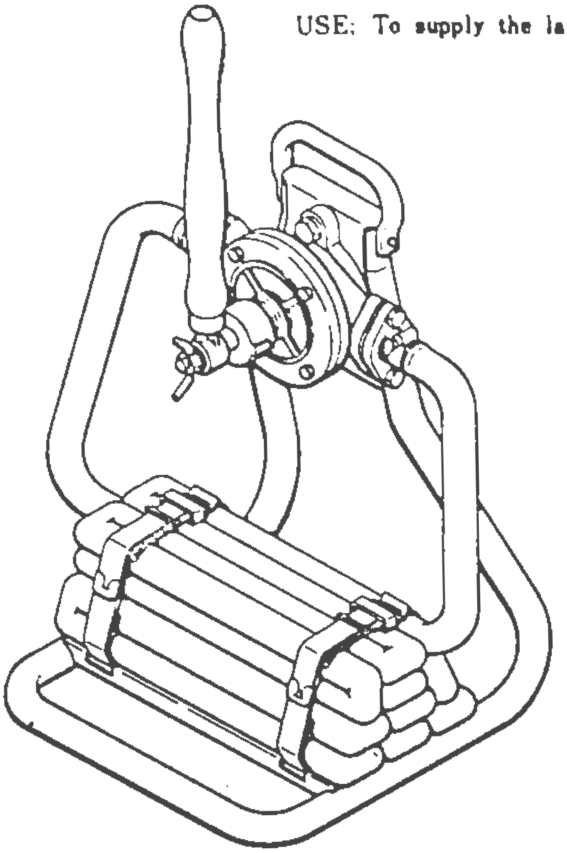


Figure 16–4

01-89035-1 Hand Pump-Water Supply, Lavatory
01-89035-101 Hand Pump-Water Supply, Lavatory

USE: To supply the lavatory wash water.



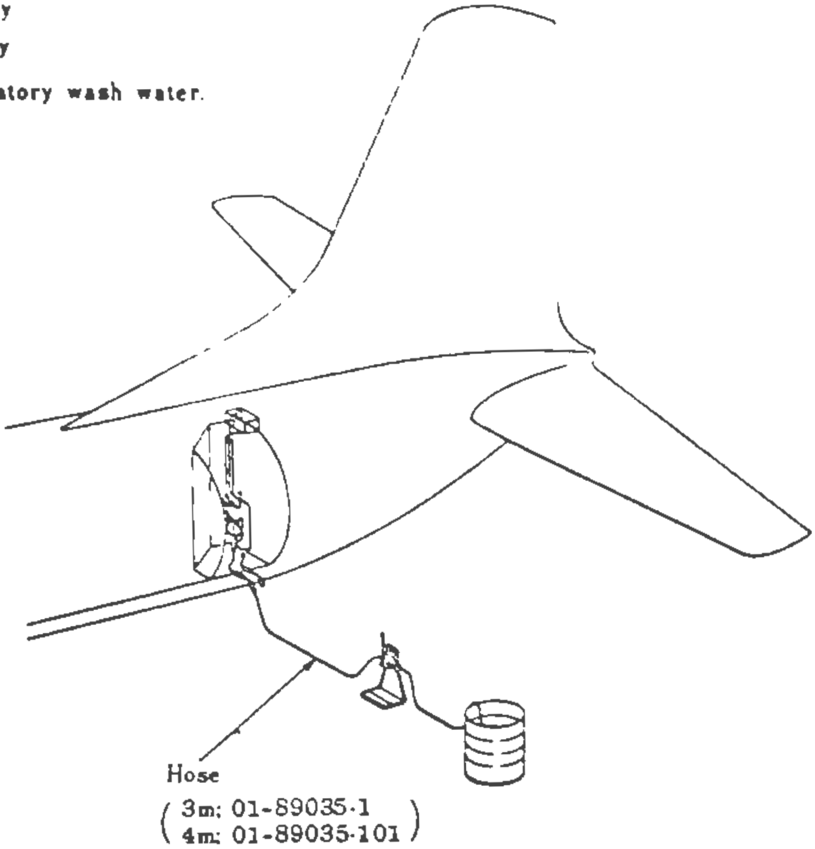


Figure 16–5

01-96801-1 Surface Clamp-Aileron Inboad, LH
01-96801-2 Surface Clamp-Aileron Inboad, RH
01-96803-1 Surface Clamp-Aileron Outboad, LH
01-96803-2 Surface Clamp-Aileron Outboad, RH

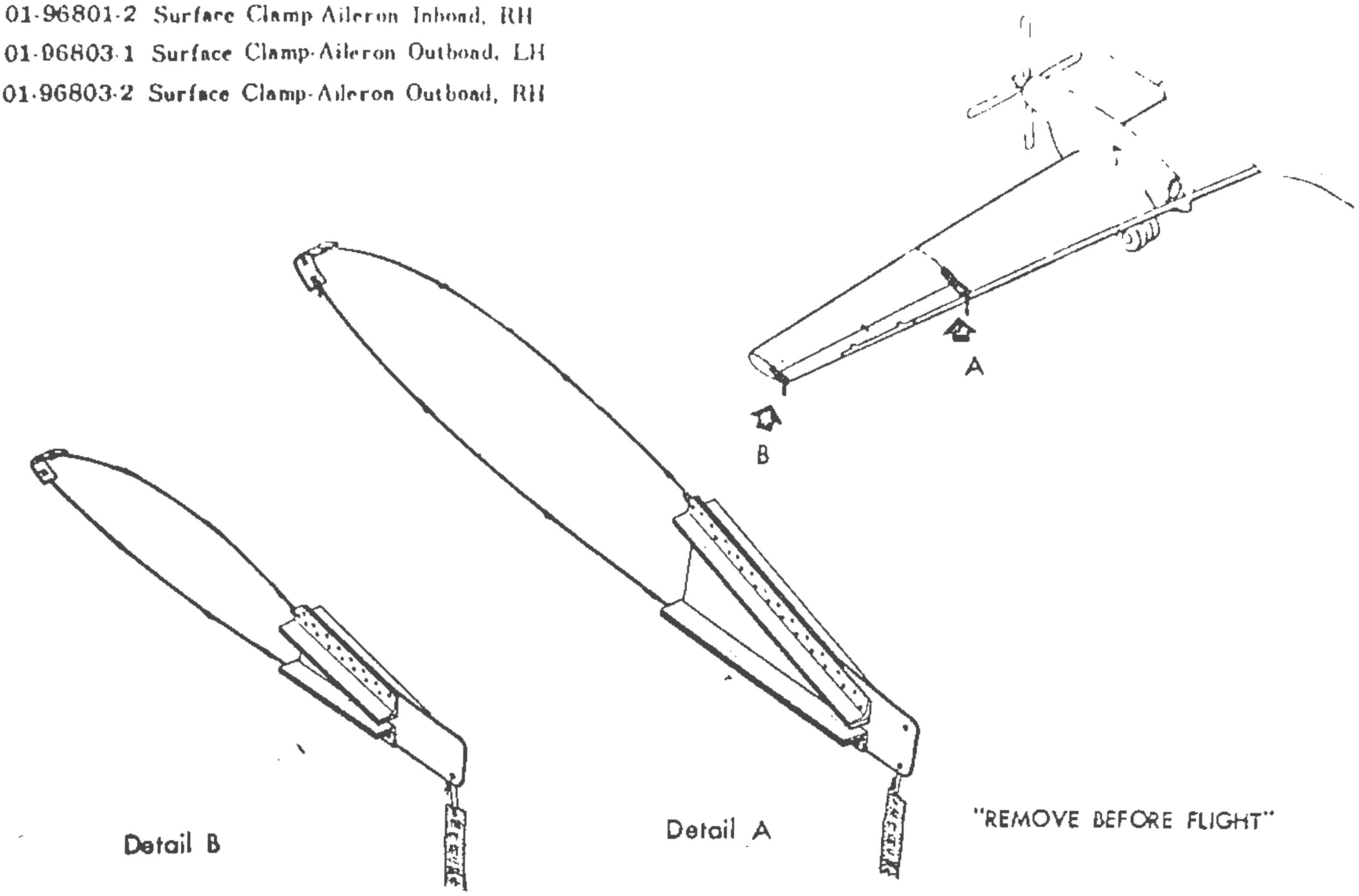


Figure 16–6

01-96160-11 Tow Bar
USE: To tow the aircraft during ground handling when engines are not running

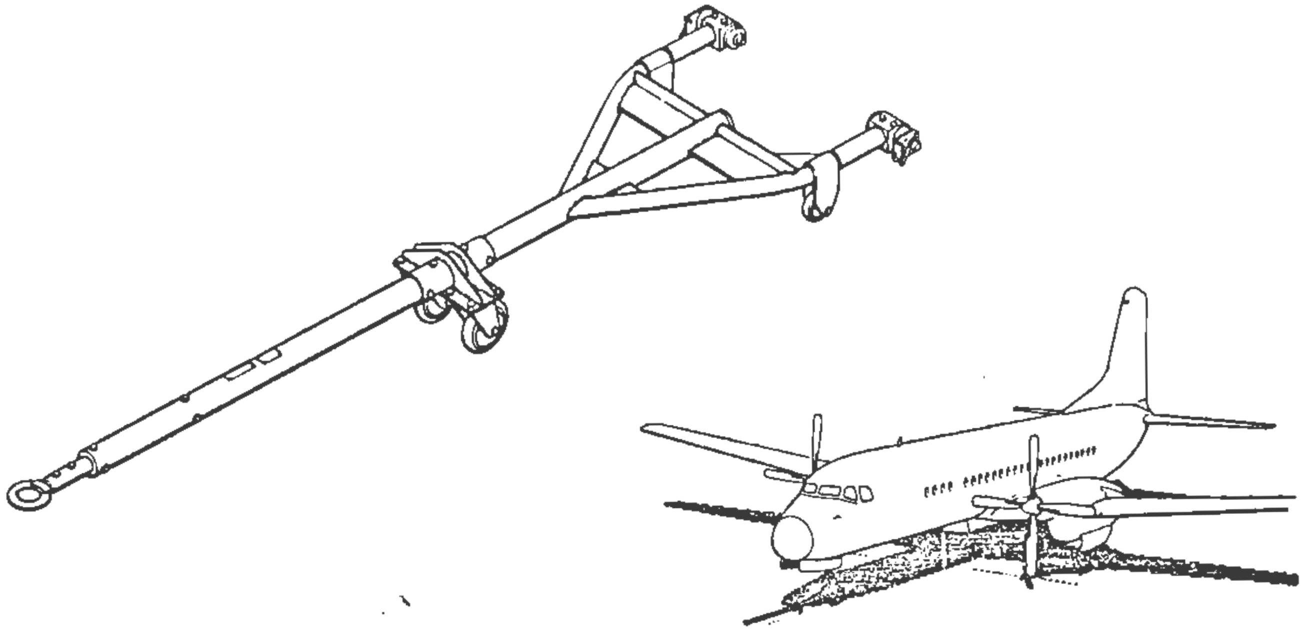
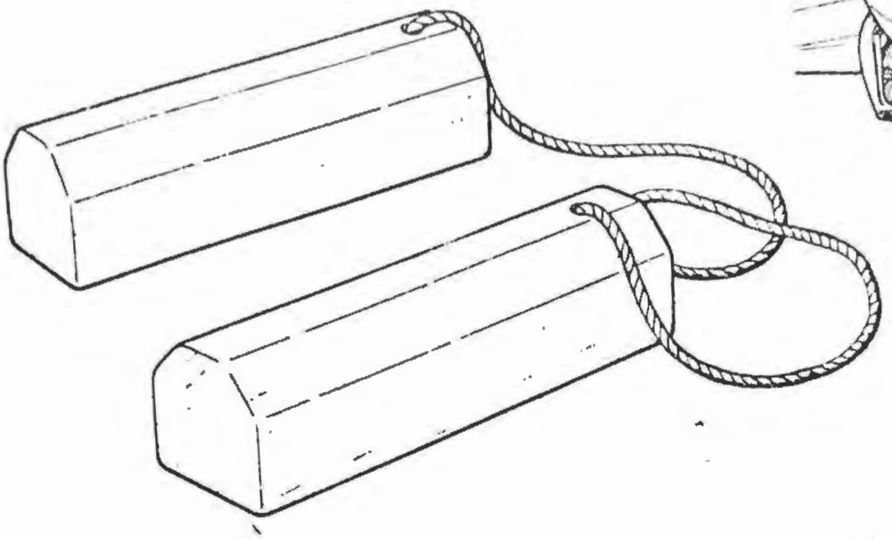
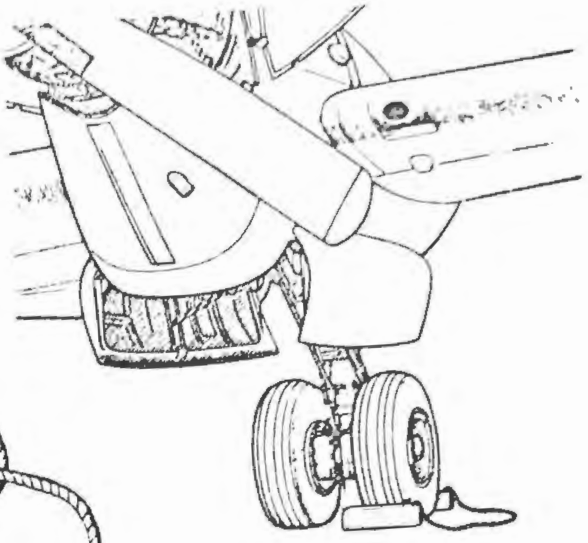


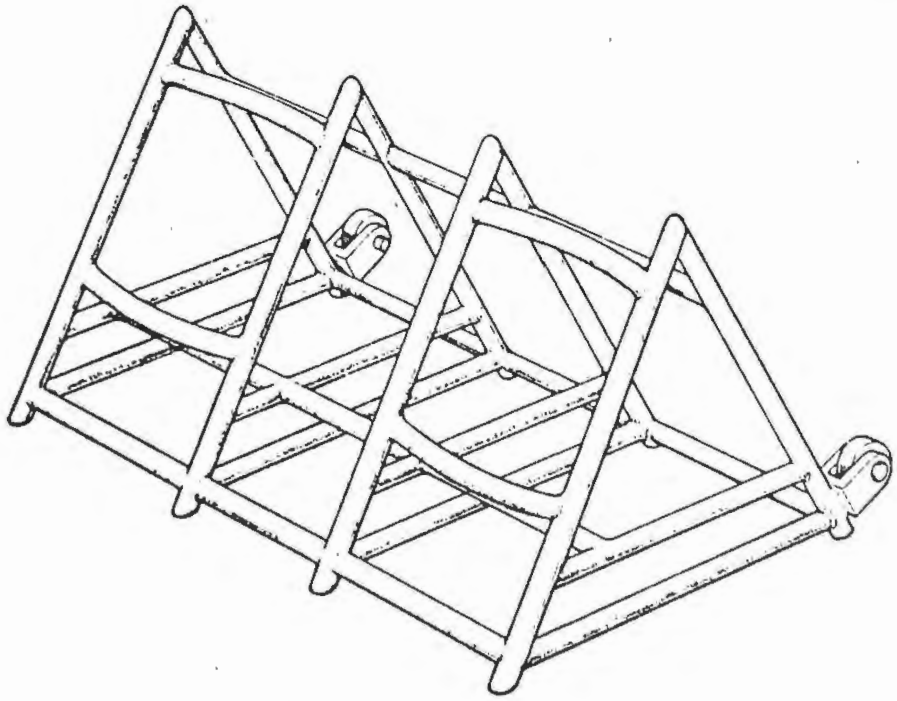
Figure 16–7

Reference Main wheel Chock
USE: To chock the main wheels during parking





Reference Main Wheel Chocks
USE: To chock the main wheels during engine run up test.



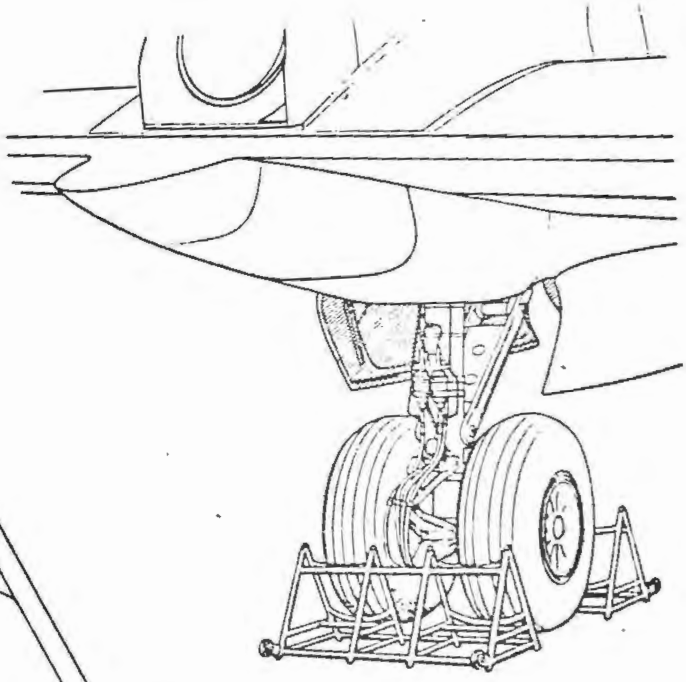
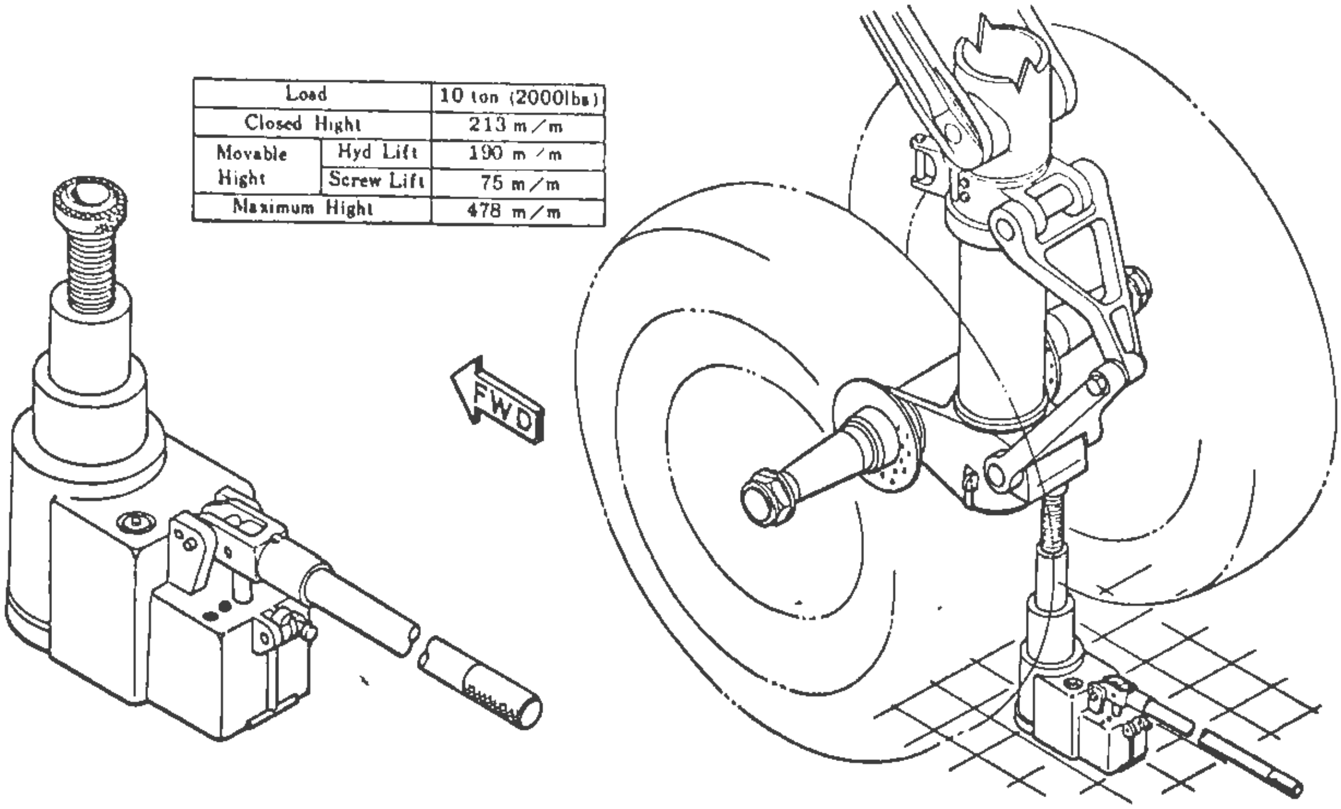


Figure 16–8

Reference

Jack-Main Landing Gear P/N: AZS10-8.4, MFR: KYB
USE: To jack up the main landing gear for changing tires and brakes.

Load		10 ton (2000lbs)
Closed Hight		213 m/m
Movable Hight	Hyd Lift	190 m/m
	Screw Lift	75 m/m
Maximum Hight		478 m/m



Reference

Jack-Nose Landing Gear P/N: AZS10-6.9, MFR: KYB
USE: To jack up the nose landing gear for changing tires.

Load		10 ton (2000lbs)
Closed Hight		178 m/m
Movable Hight	Hyd Lift	180 m/m
	Screw Lift	75 m/m
Maximum Hight		432 m/m

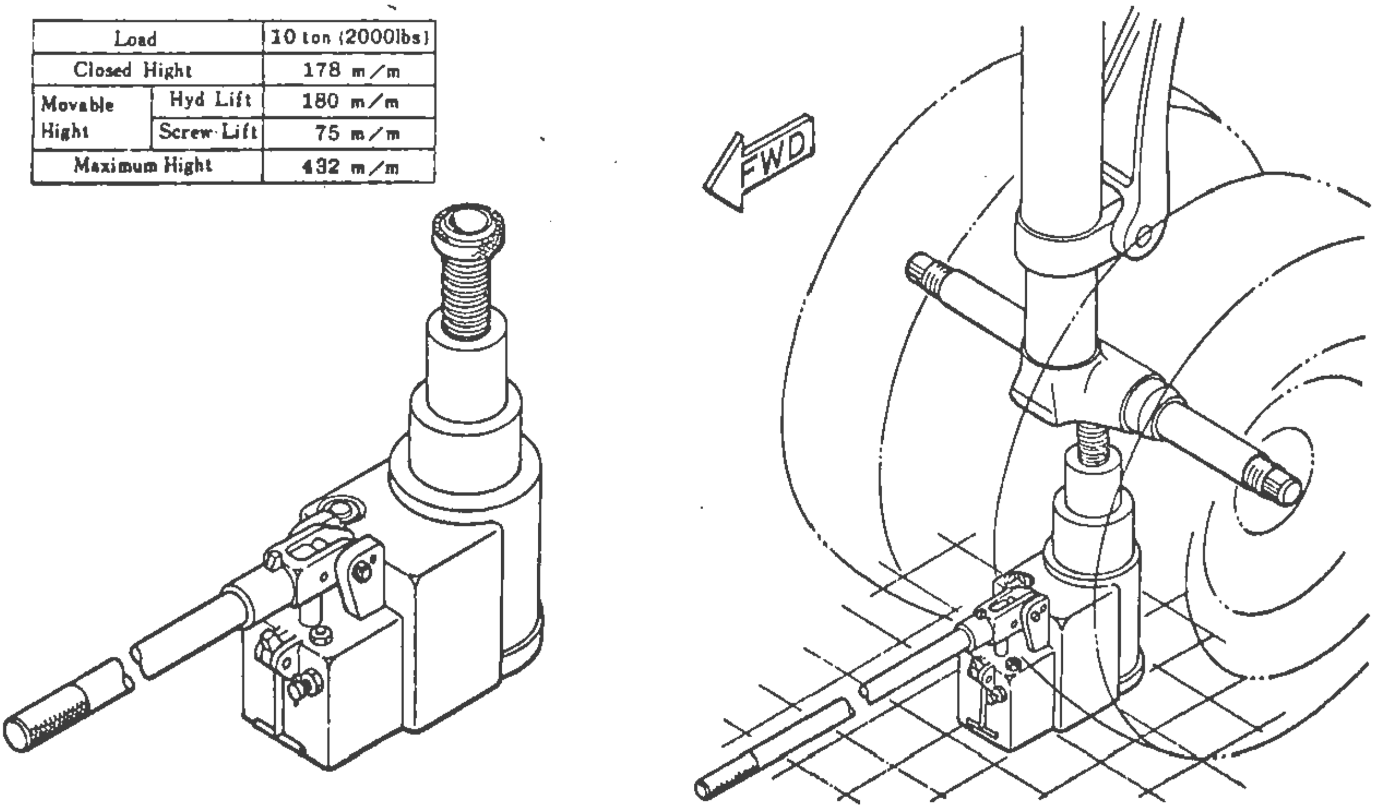
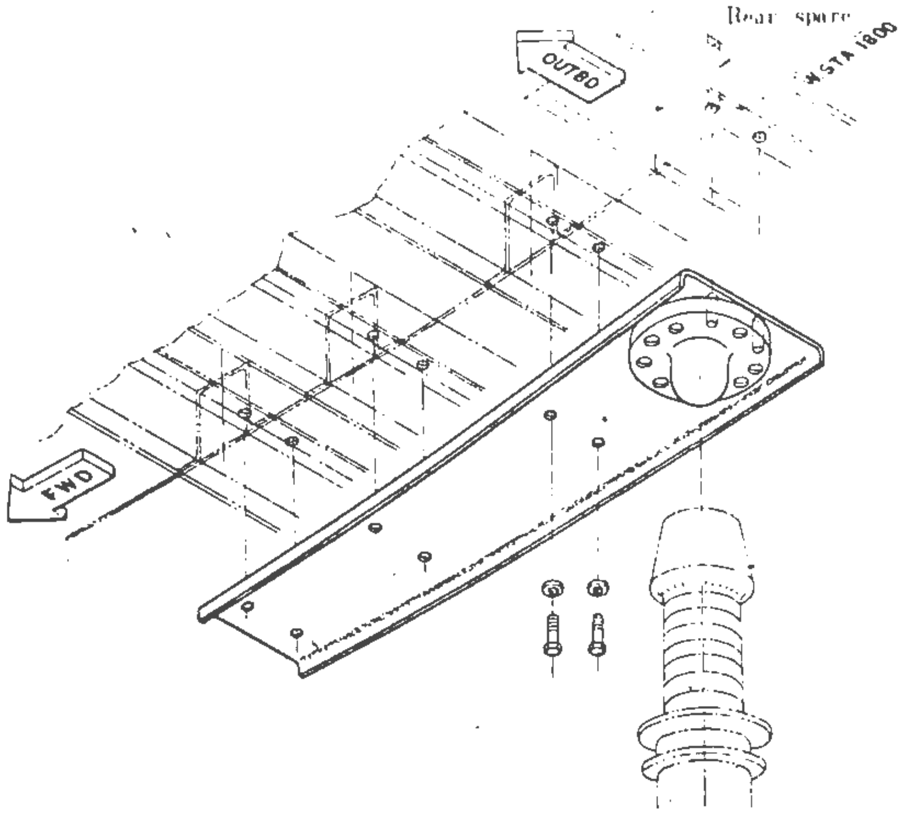
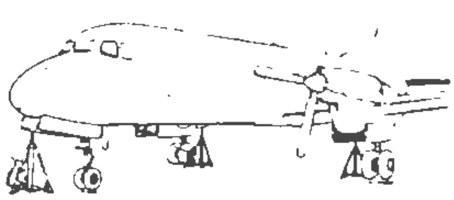


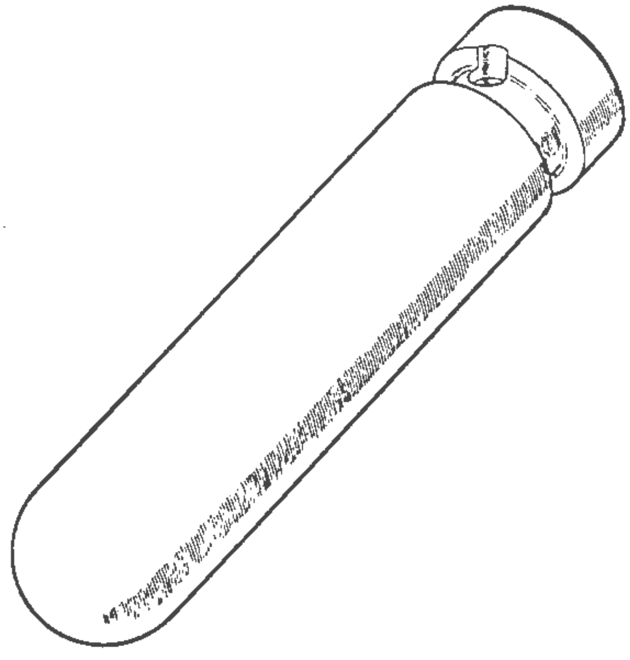
Figure 16–9

01-96204-1 Main Jack Pad
USE: In conjunction with main jack.





01-96052 Nose Jack Pad
USE: In conjunction with main jack.



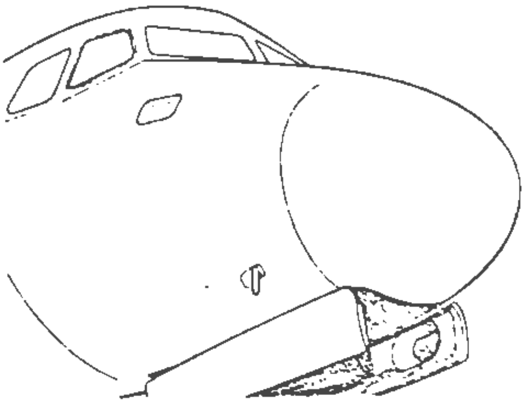
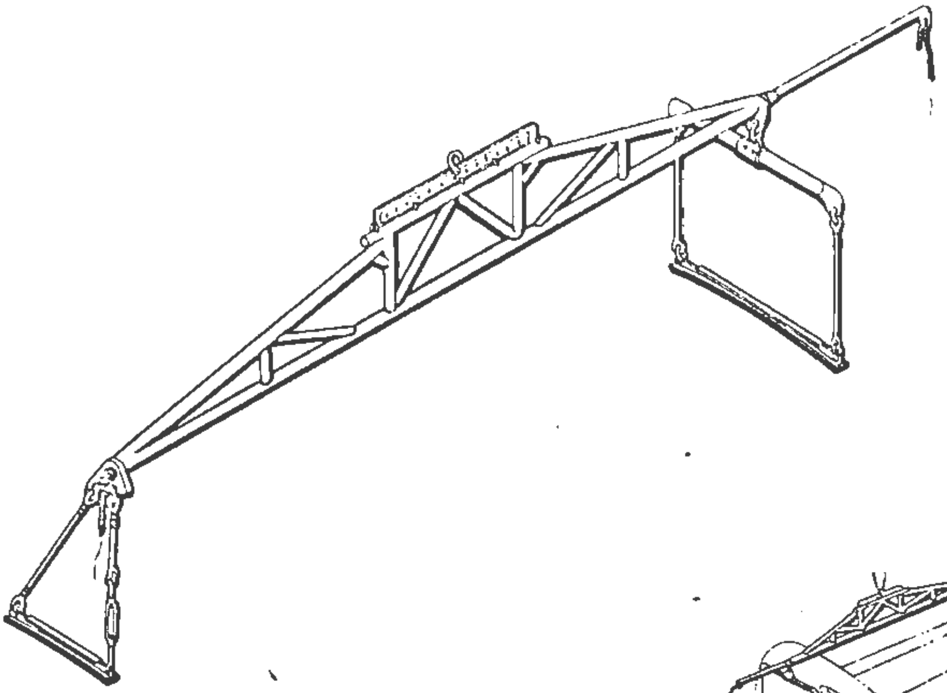
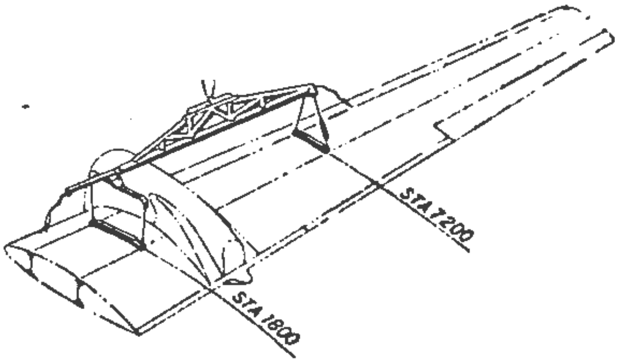


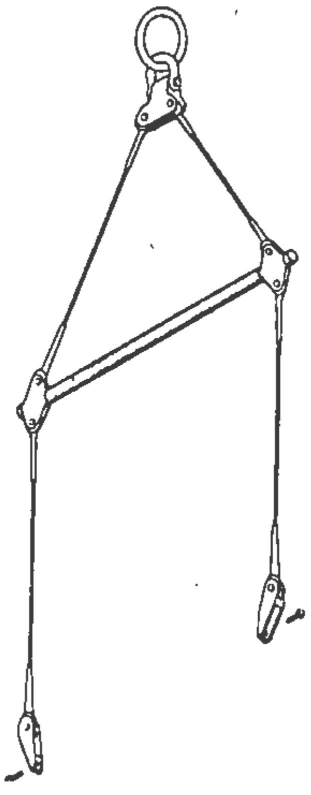
Figure 16-10

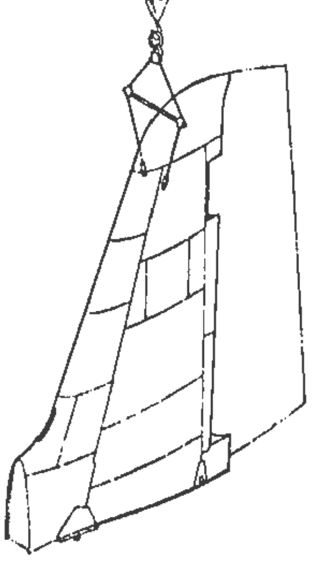
01-96217 Outer Wing Sling (including bolts for fitting
USE: To hoist and support the outerwing when removing or installing.





01-96601 Vertical Tail Sling (including bolts for fitting)
USE: To hoist the vertical tail or the vertical stabilizer and the the rudder respectively.





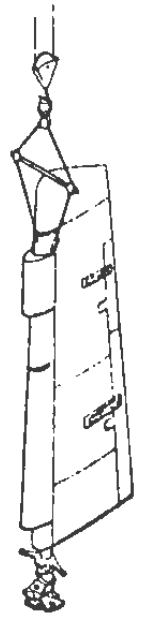
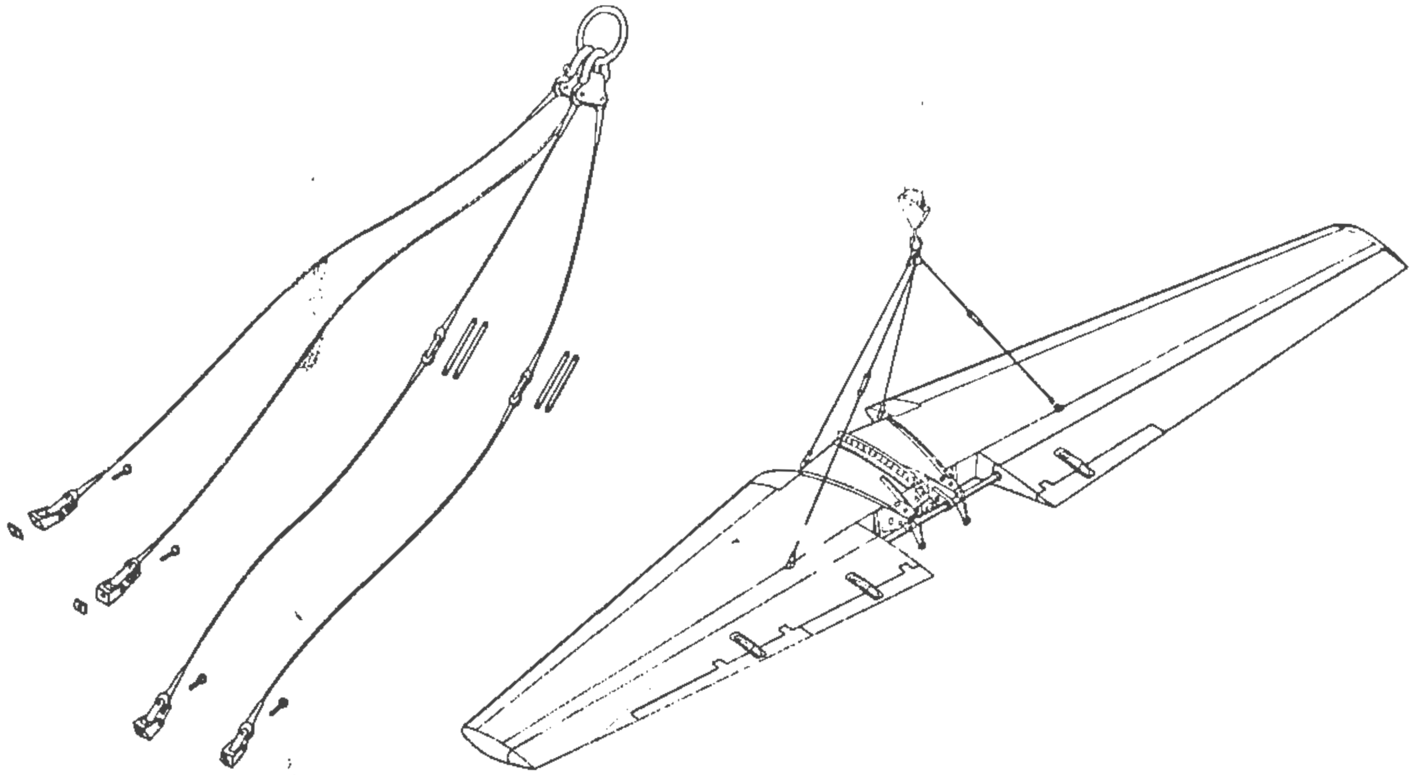


Figure 16-11

01-96610 Horizontal Tail Sling (including bolts for fitting)
USE: To hoist complete horizontal tail or horizontal stabilizer.



01-86010 Support Stick, After Fuselage
USE: To supprot the after fuselage during engine change.

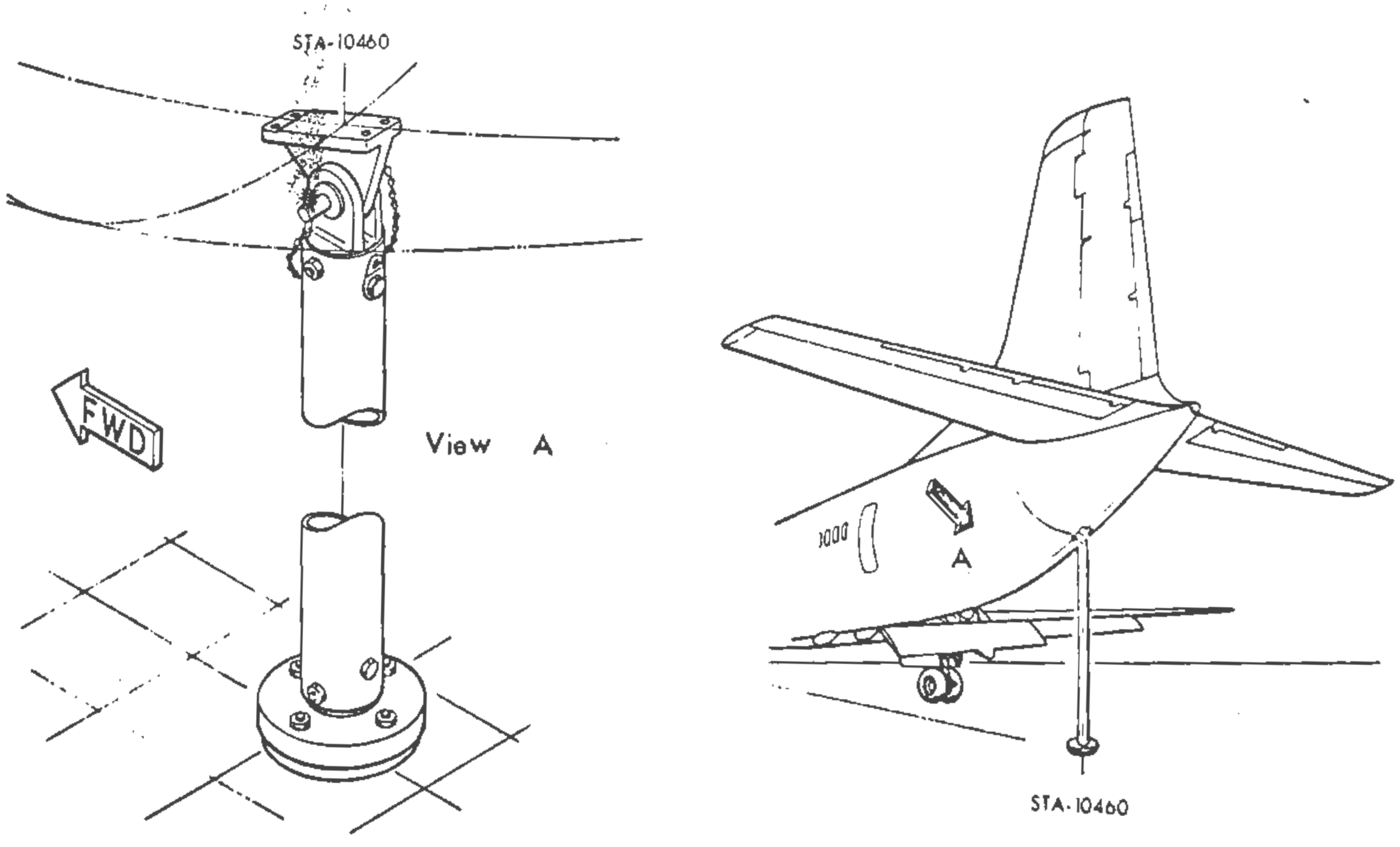
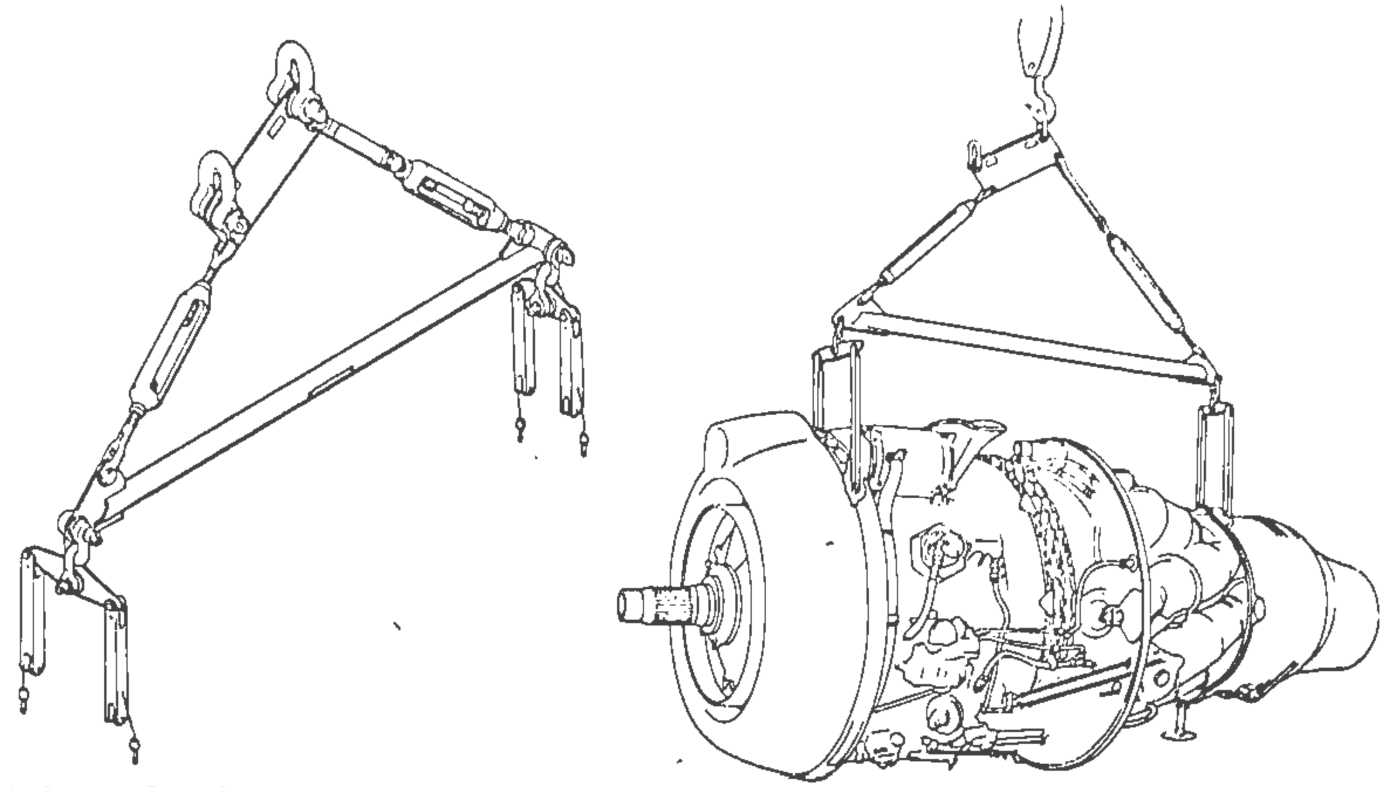


Figure 16–12

Reference

Engine Sling P/N. GZ02086/1. MFR: RR

USE. To hoist the engine for installation and removal with or without propeller.



01-96253 Sling-Gear Box and Tail Pipe

USE: To hist the gear box or tail pipe.

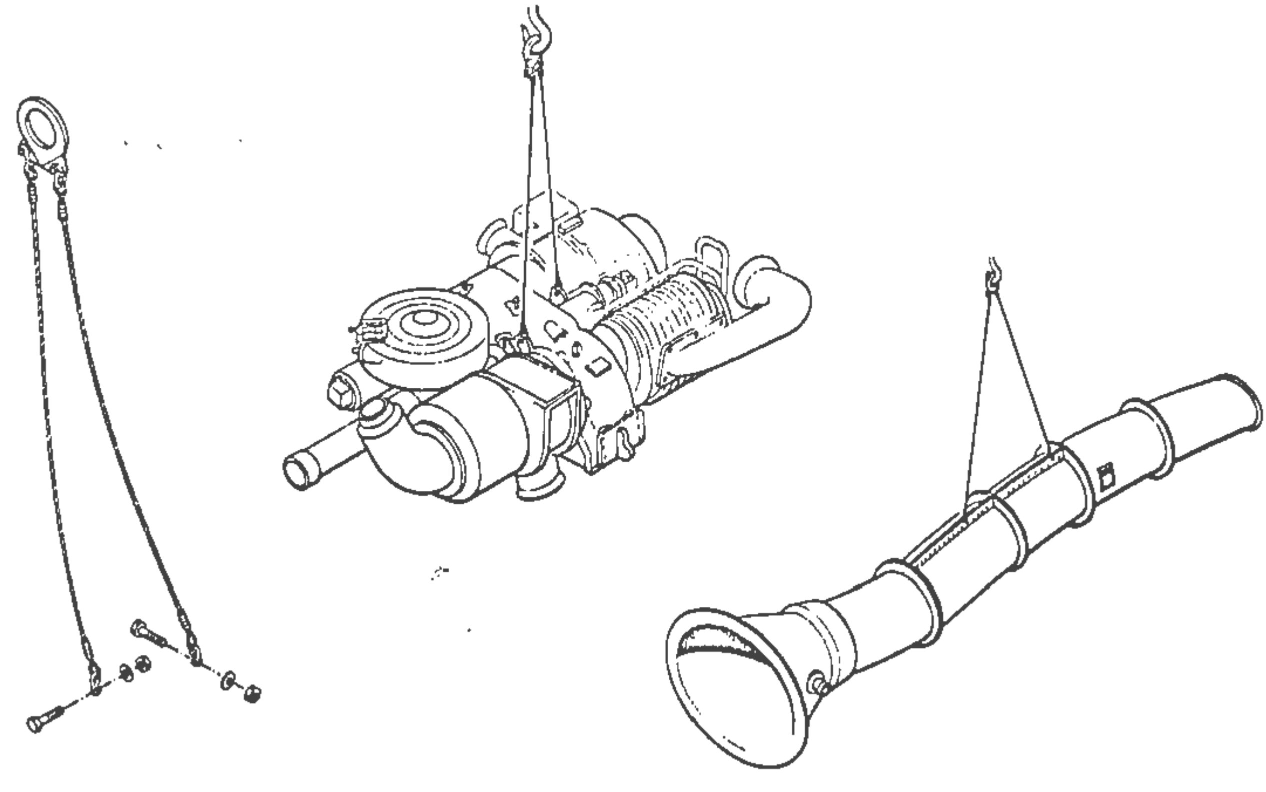
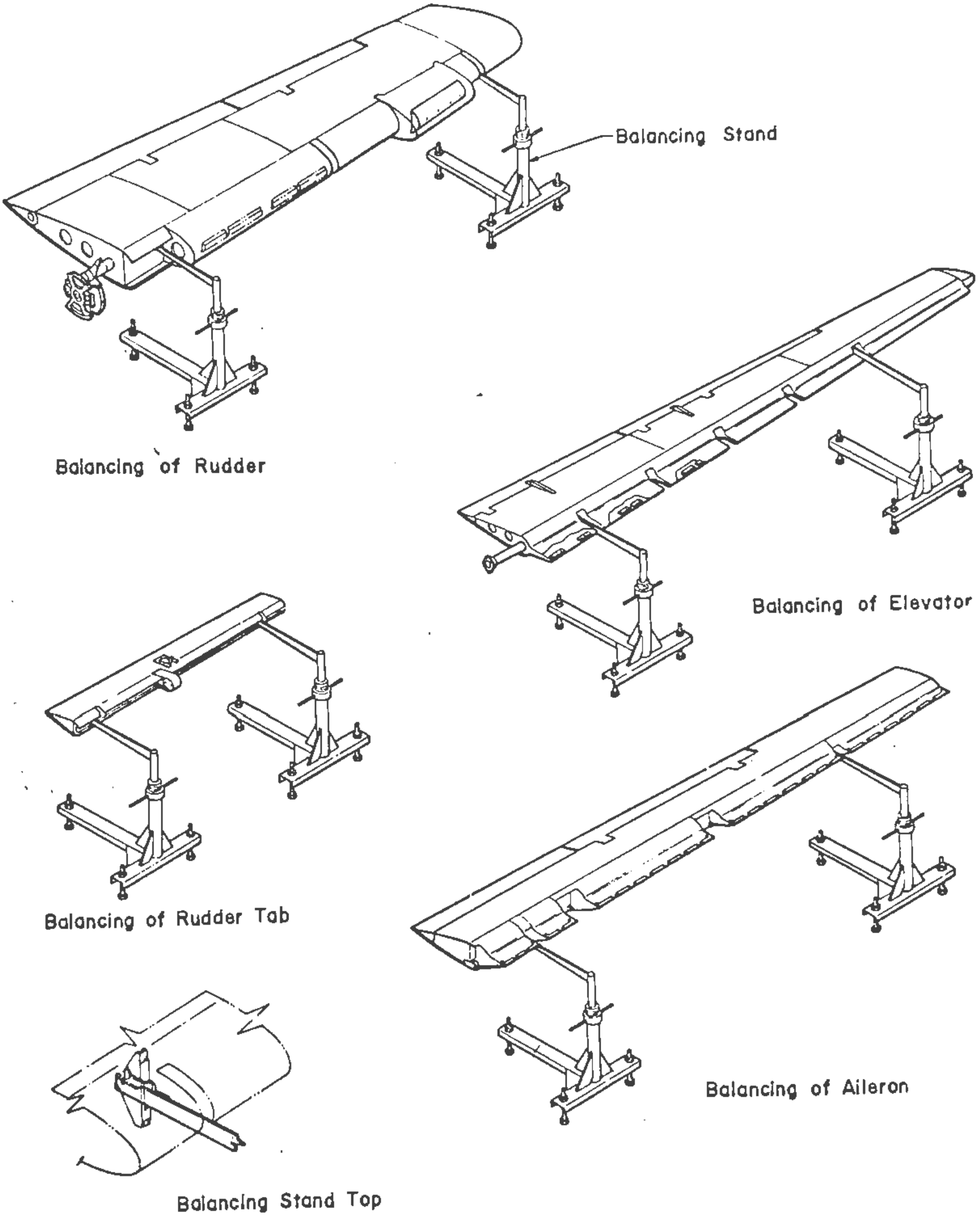


Figure 16—13

01-23001-934 Balancing Stand-Control Surface (including tabs)
USE: To use balancing of control surface (including tabs)



Balancing of Rudder

Balancing of Elevator

Balancing of Rudder Tab

Balancing of Aileron

Balancing Stand Top

Figure 16–14

01-66001-13H Propeller Stand Dolly
USE: Tor transportation and storage of propeller.

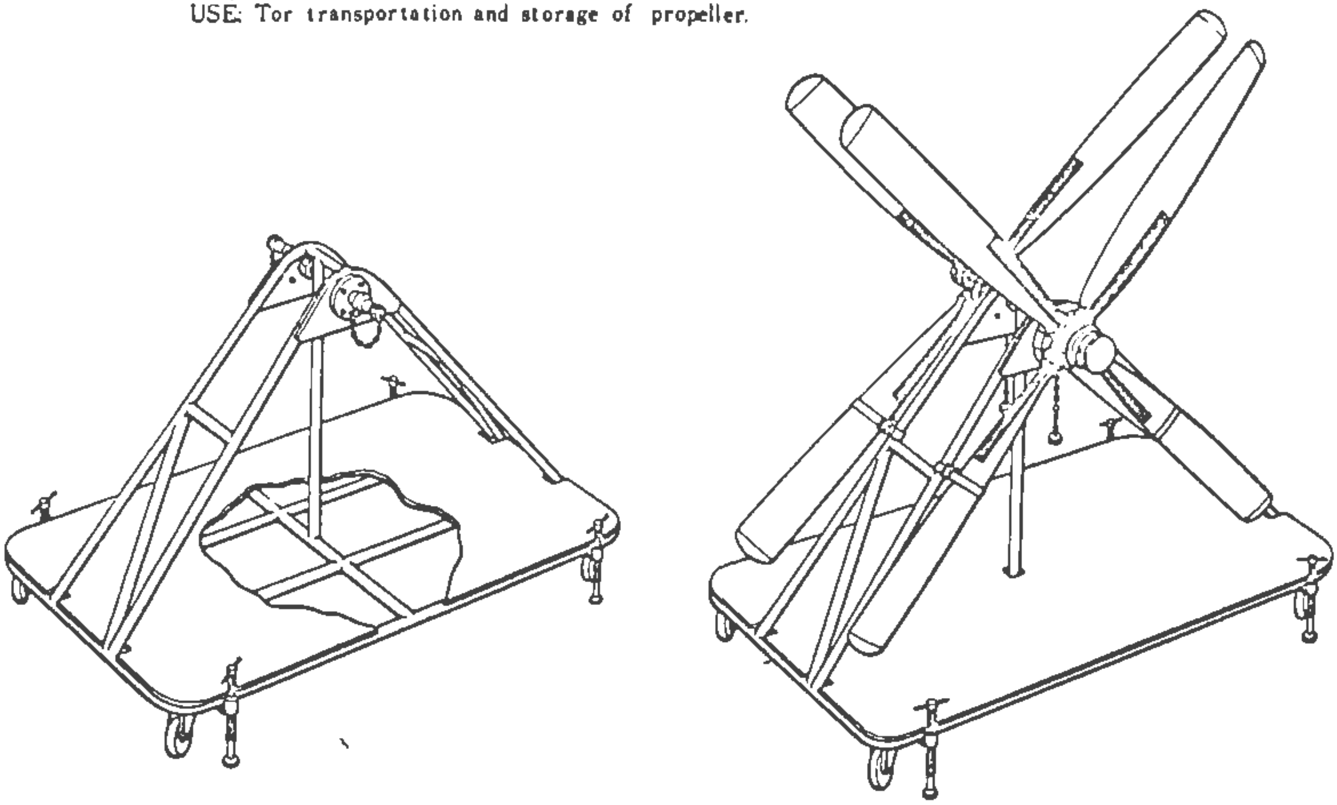


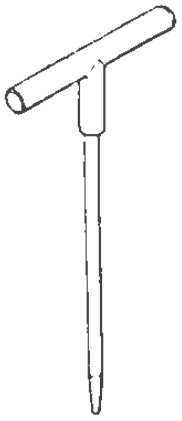
Figure 16–15

Rig Pin

Note; As for details of usage, ref the each systems as follow.

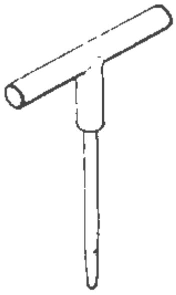
01-96072

1 ea



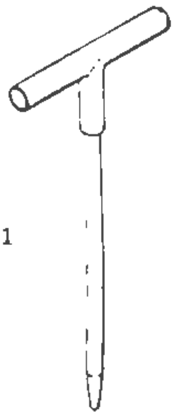
01-96072-11

4 ea



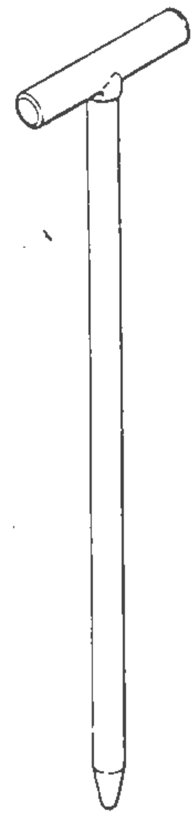
01-96073-31

30 ea



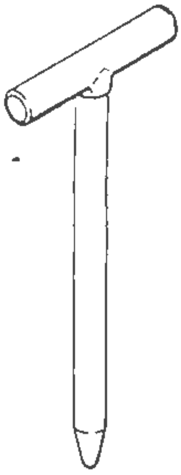
01-96075-11

3 ea



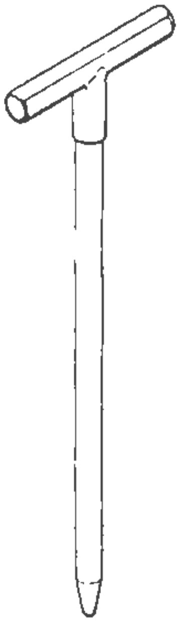
01-96075-21

4 ea



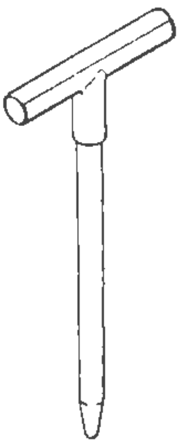
01-96230-11

4 ea



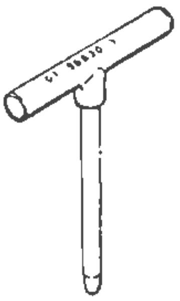
01-96230-91

19 ea



01-96630-1

2 ea



01-96230-31

2 ea

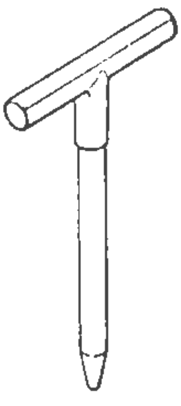
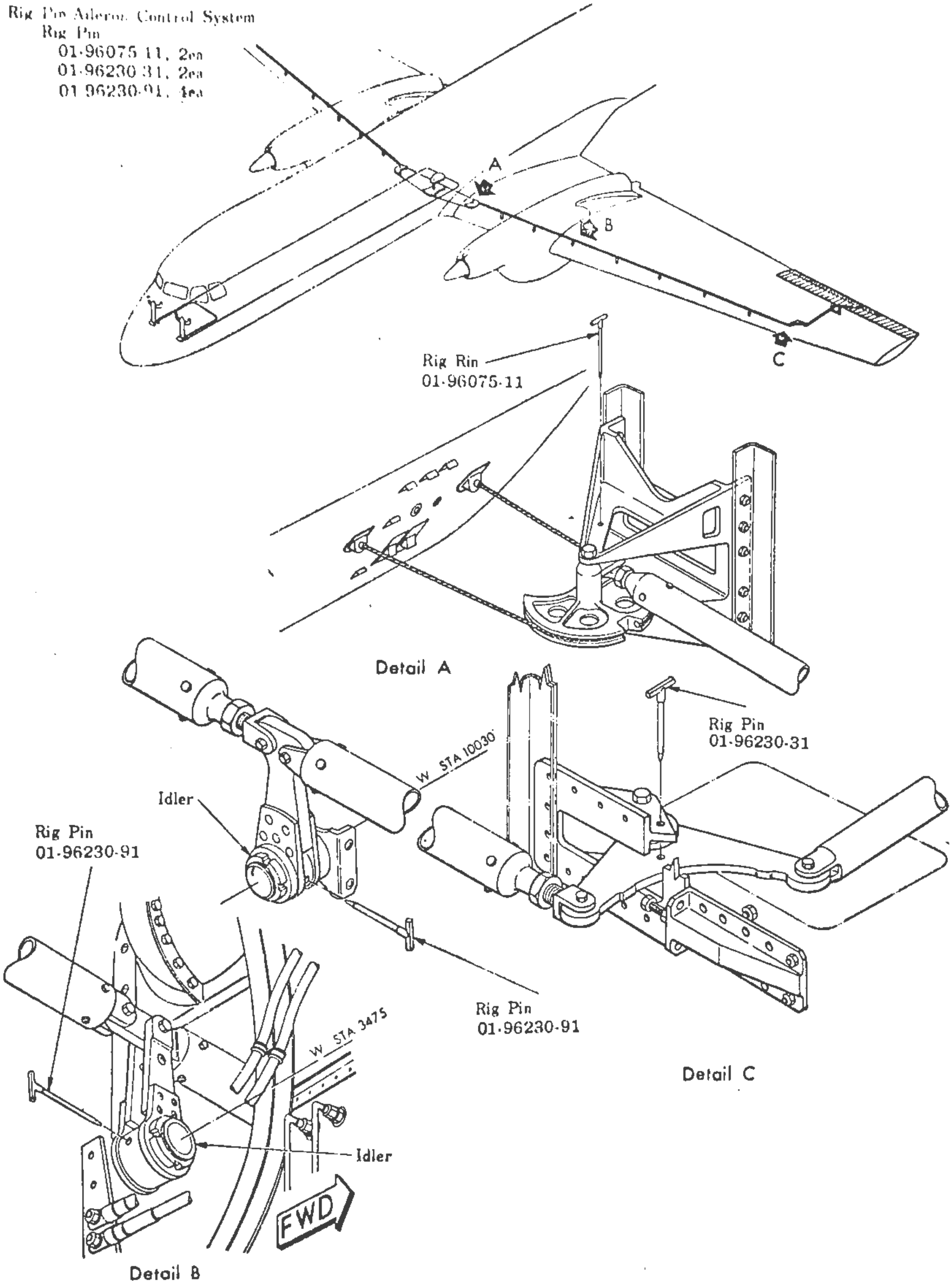


Figure 16–16



Rig Pin Aileron Control System
Rig Pin
01-96075-11, 2ea
01-96230-31, 2ea
01-96230-91, 4ea

Figure 16–17

Rig Pin-Aileron Trim Tab System
Rig Pin
01-96072-11, 1 ea
01-96230-91, 1 ea

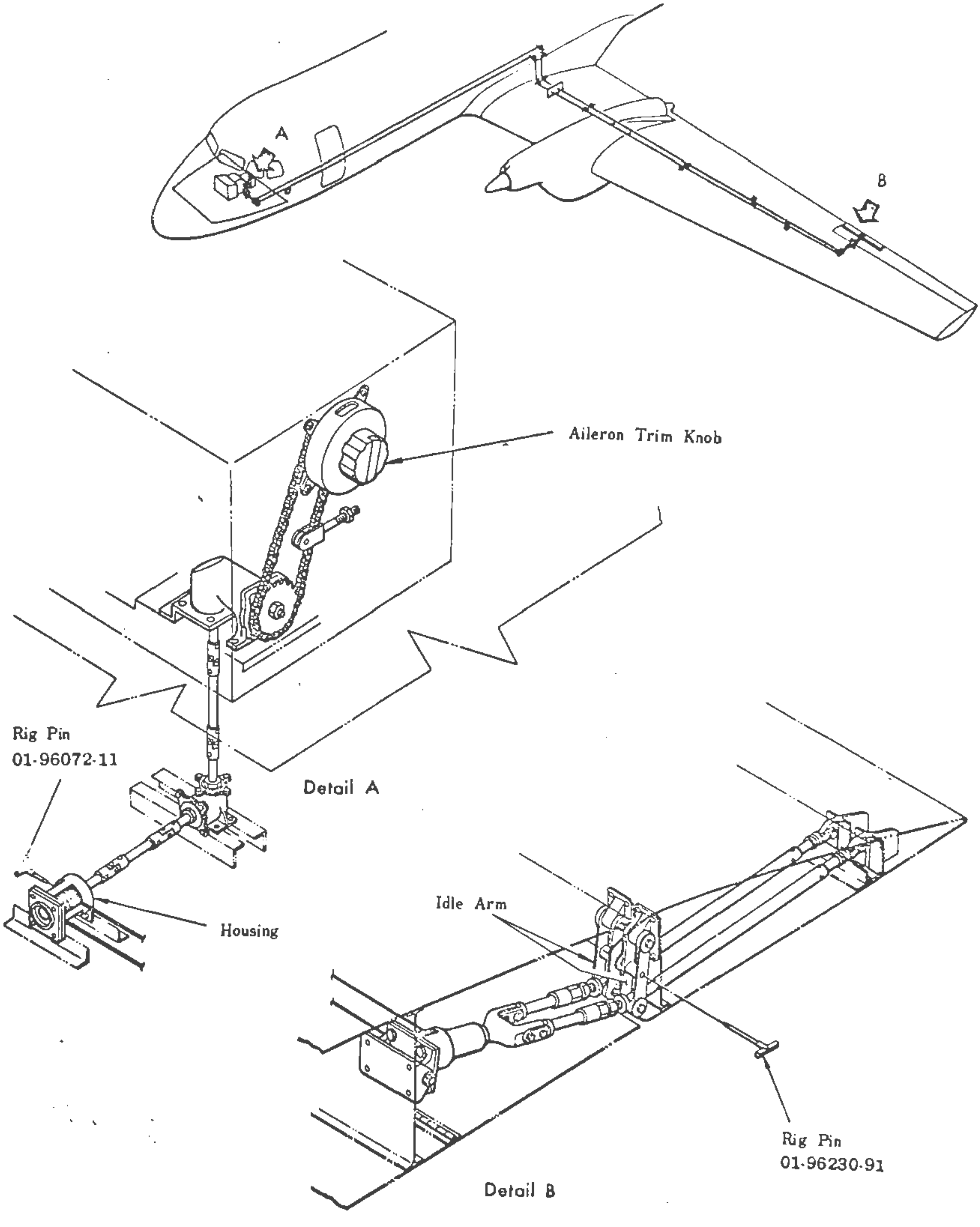
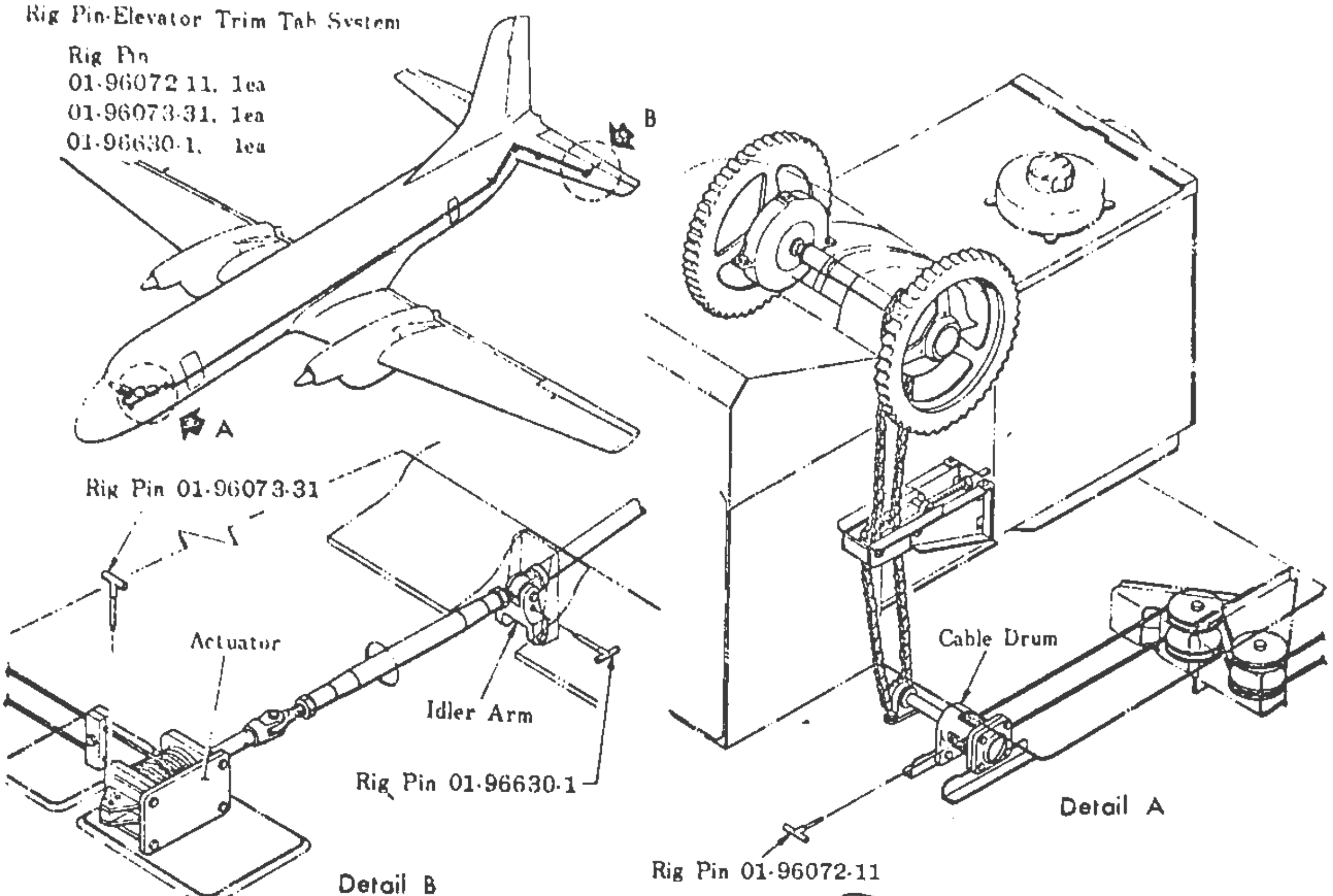
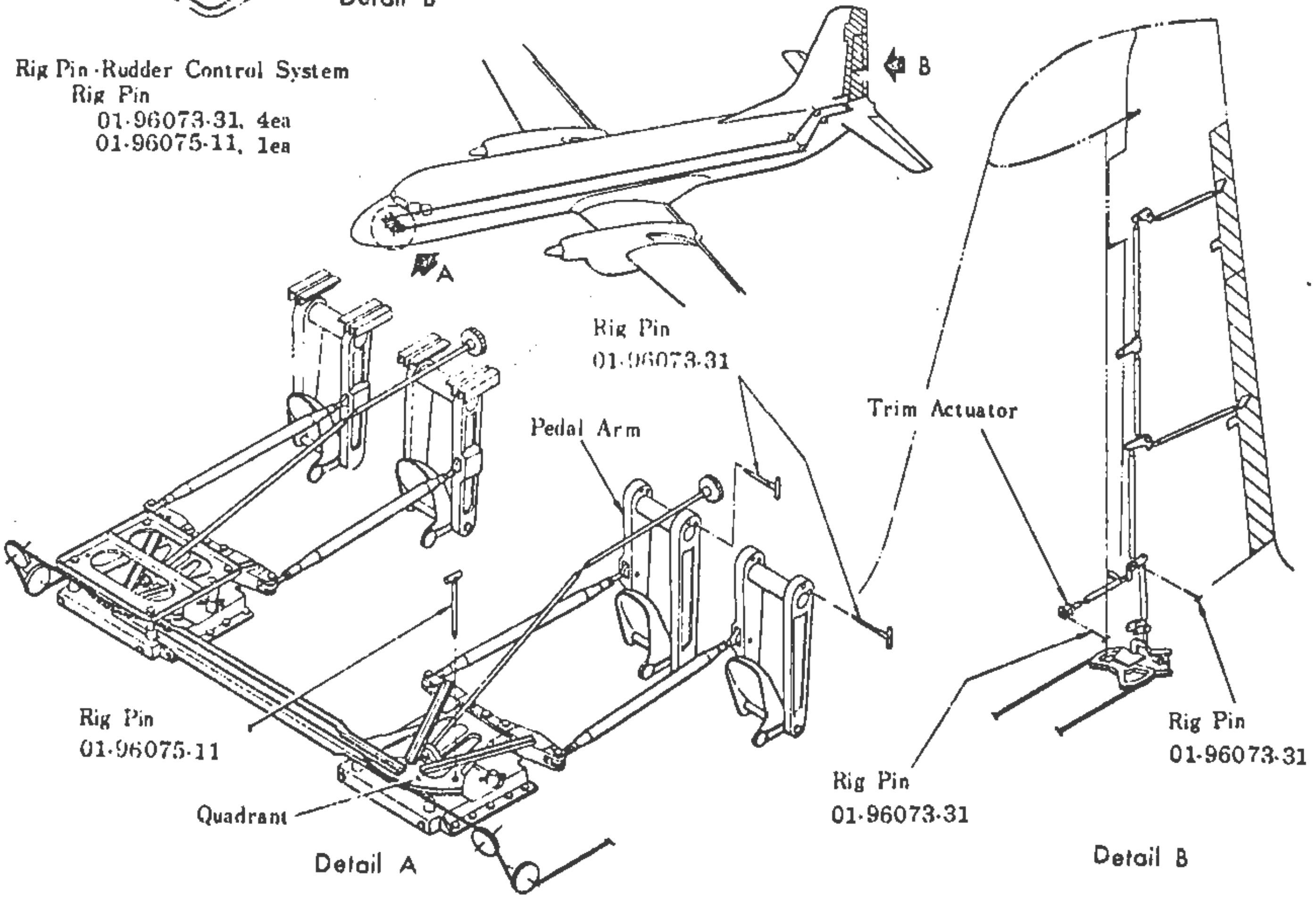


Figure 16–18

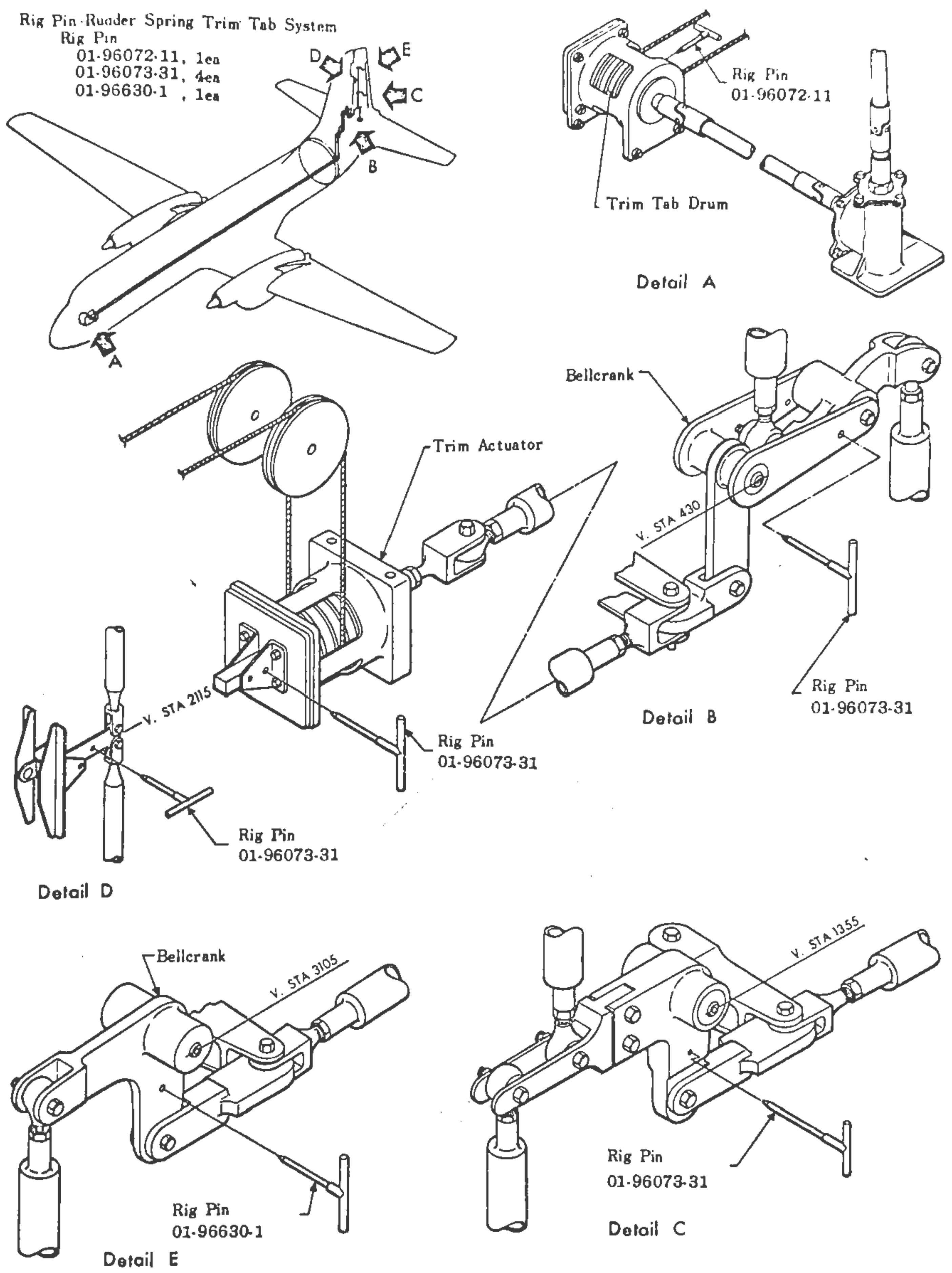

Rig Pin-Elevator Trim Tab System

Rig Pin
01-96072-11, 1ea
01-96073-31, 1ea
01-96630-1, 1ea


Rig Pin-Rudder Control System

Rig Pin
01-96073-31, 4ea
01-96075-11, 1ea

Figure 16–19



Rig Pin-Rudder Spring Trim Tab System

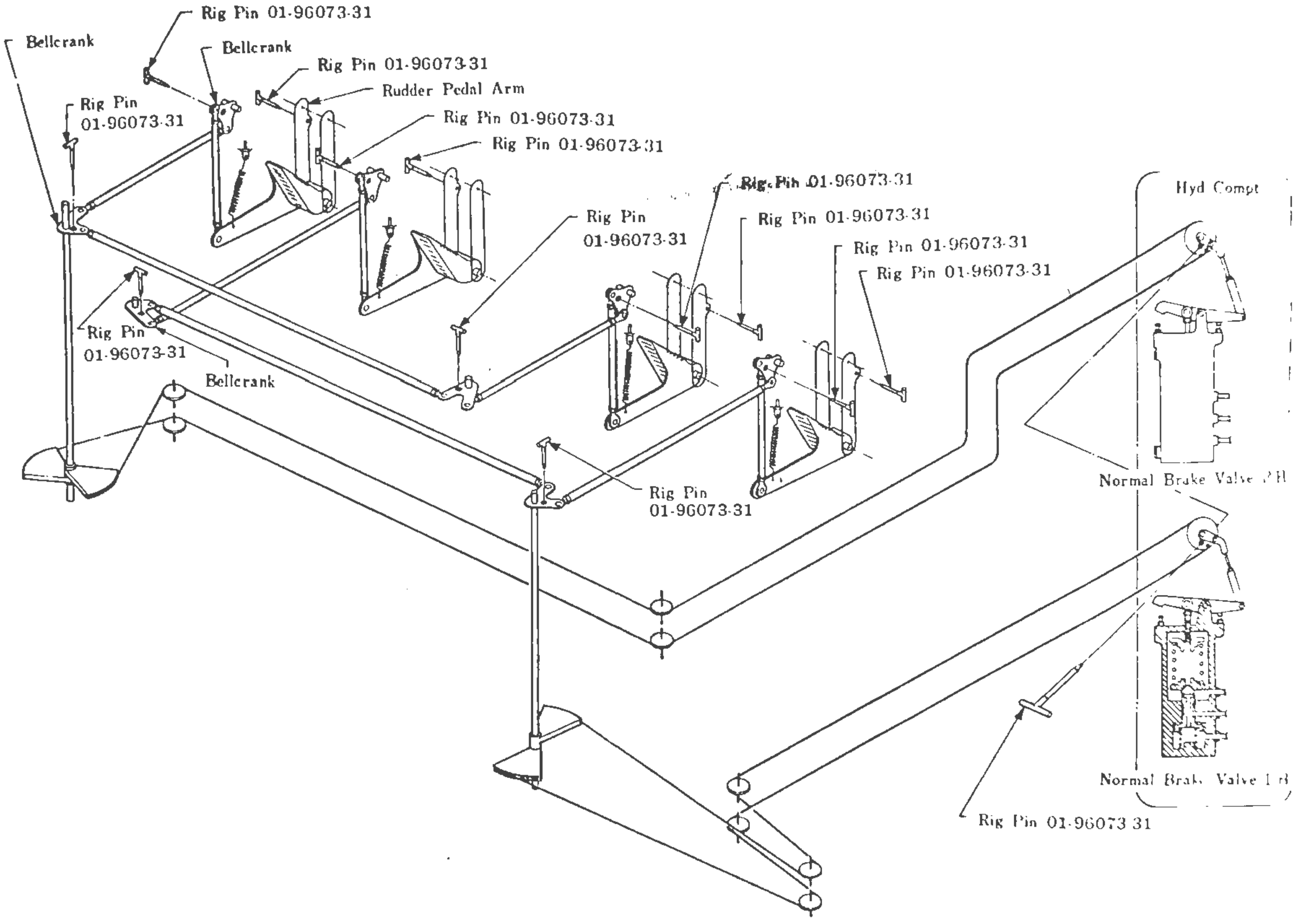
Rig Pin

01-96072-11, 1ea

01-96073-31, 4ea

01-96630-1 , 1ea

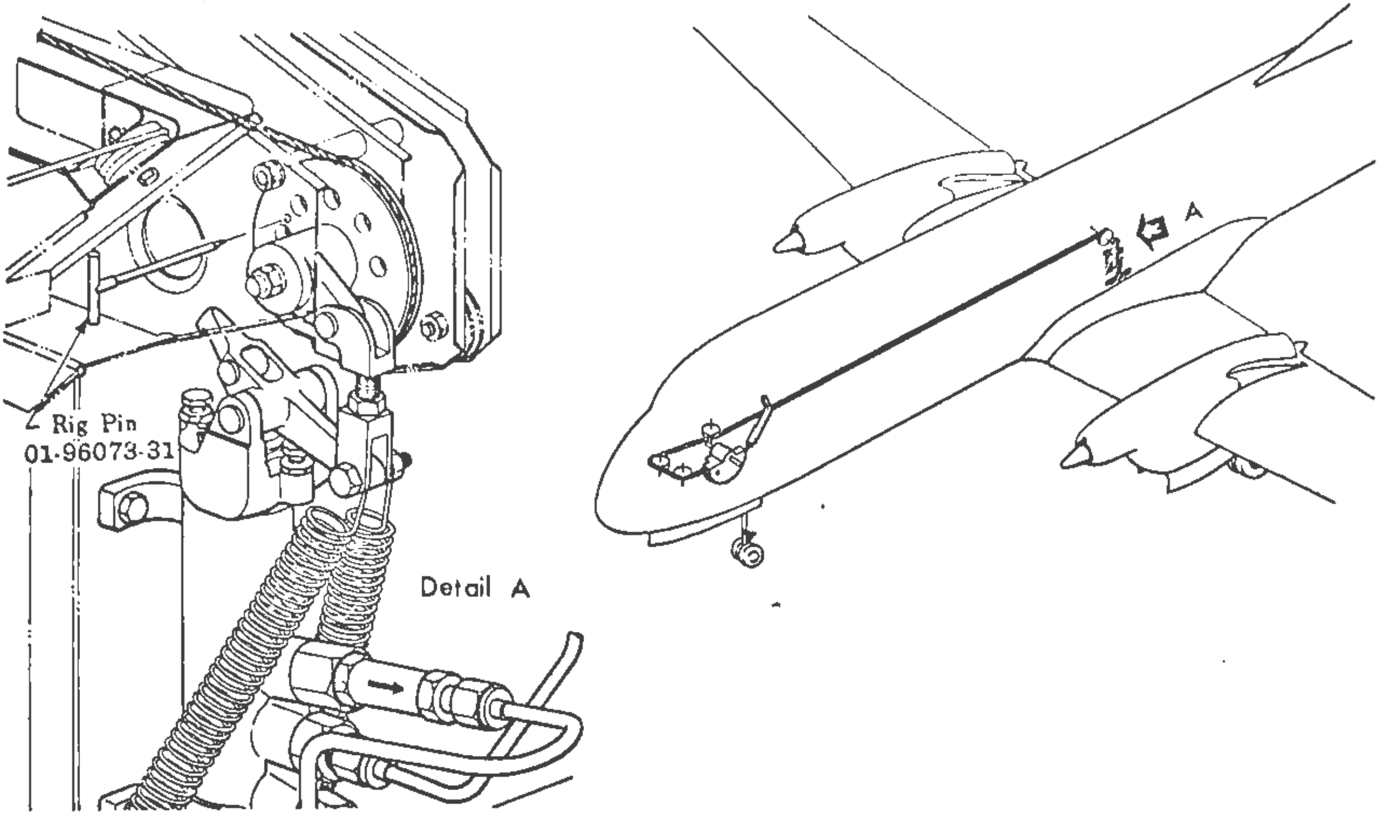
Figure 16–20



Rig Pin-Normal Brake System
Rig Pin 01-96073-31, 13ea

Figure 16–22

Rig Pin-Emergency Brake System
Rig Pin
01-96073-31, 1ea



Rig Pin-Emergency Up Lock Releace System
Rig Pin
01-96073-31, 2 ea

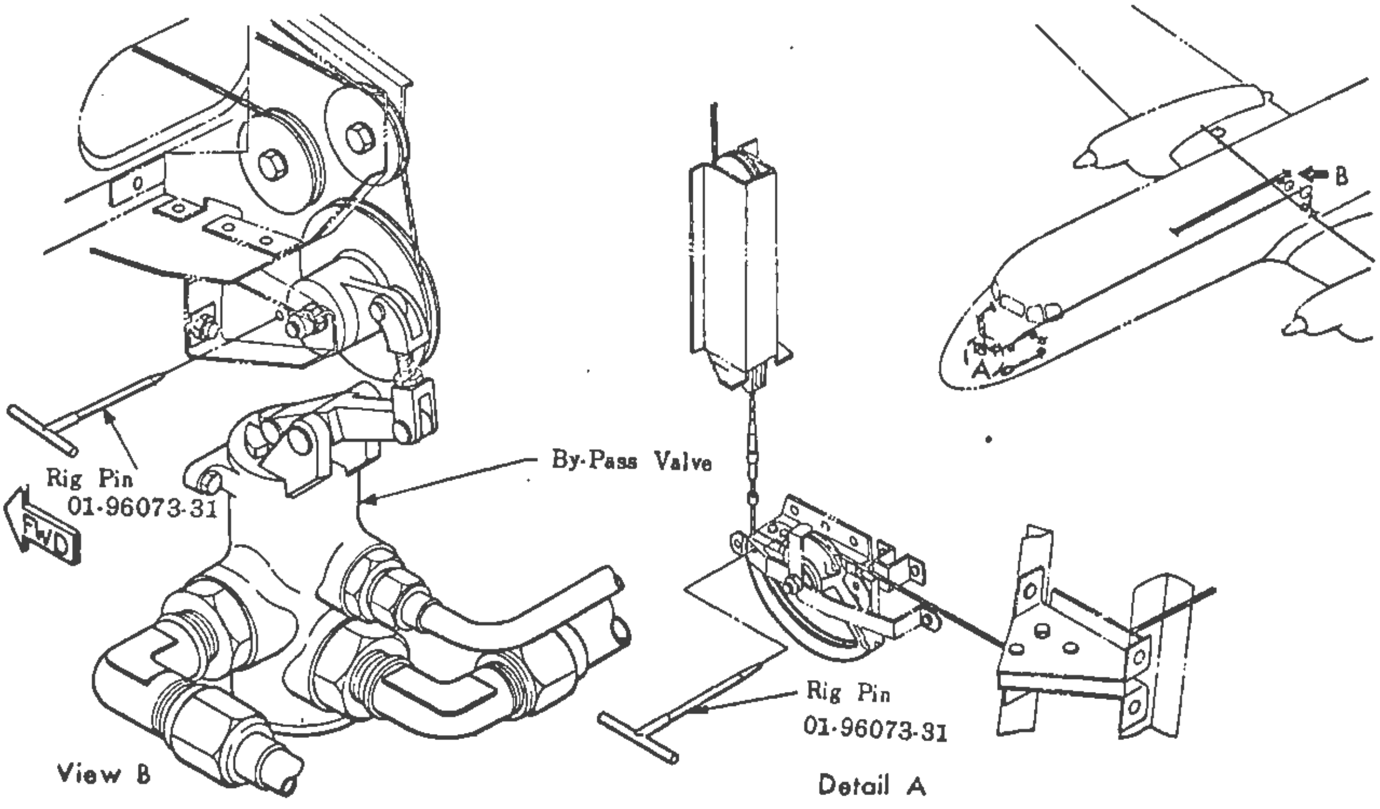


Figure 16–23

Rig Pin-Landing Gear Control System
Rig Pin
01-96072-11, 1 ea
01-96073-31, 2 ea

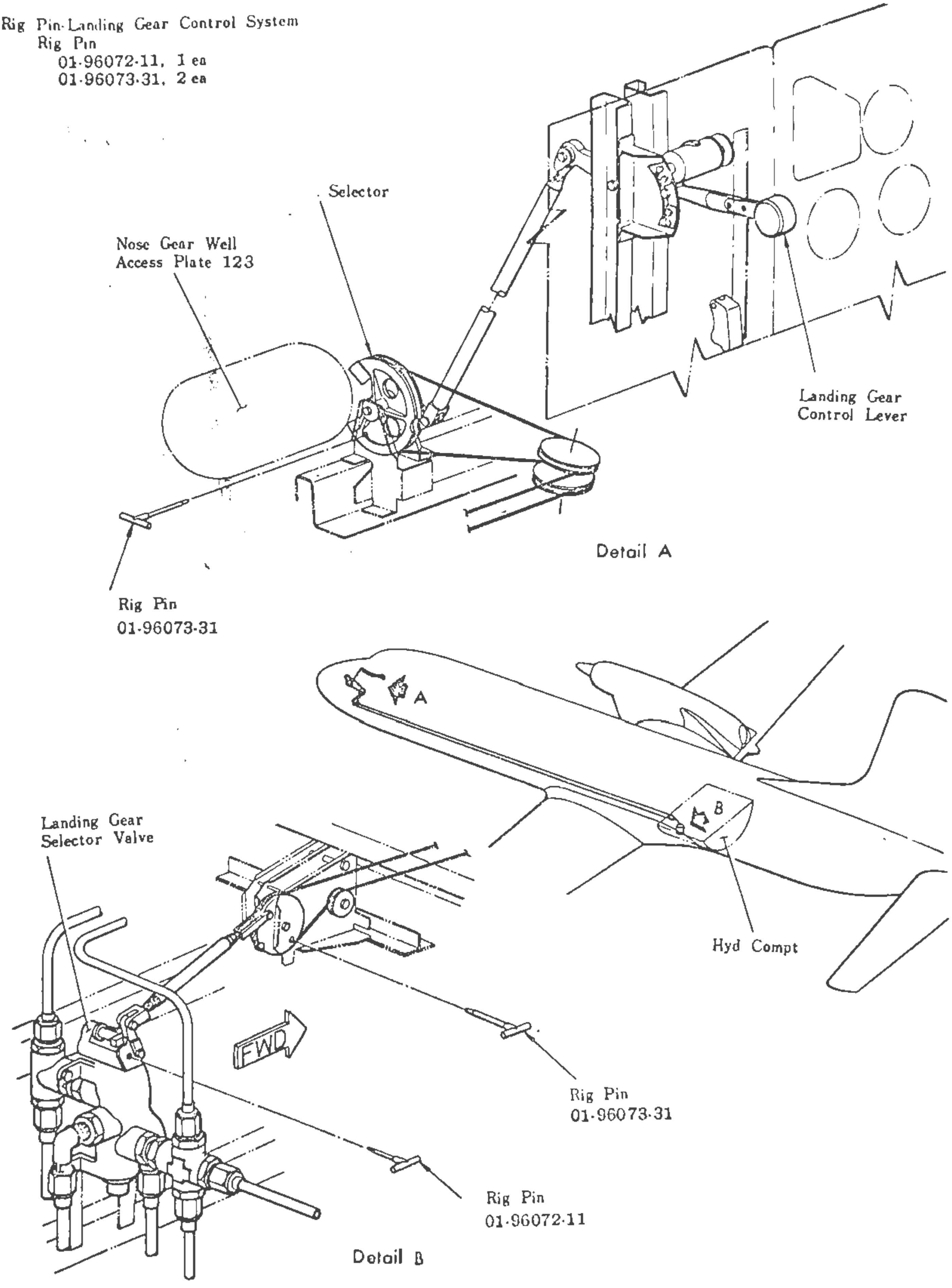


Figure 16–24

Rig Pin Steering System
Rig Pin
01-96072 1ea
01-96073-31 1ea

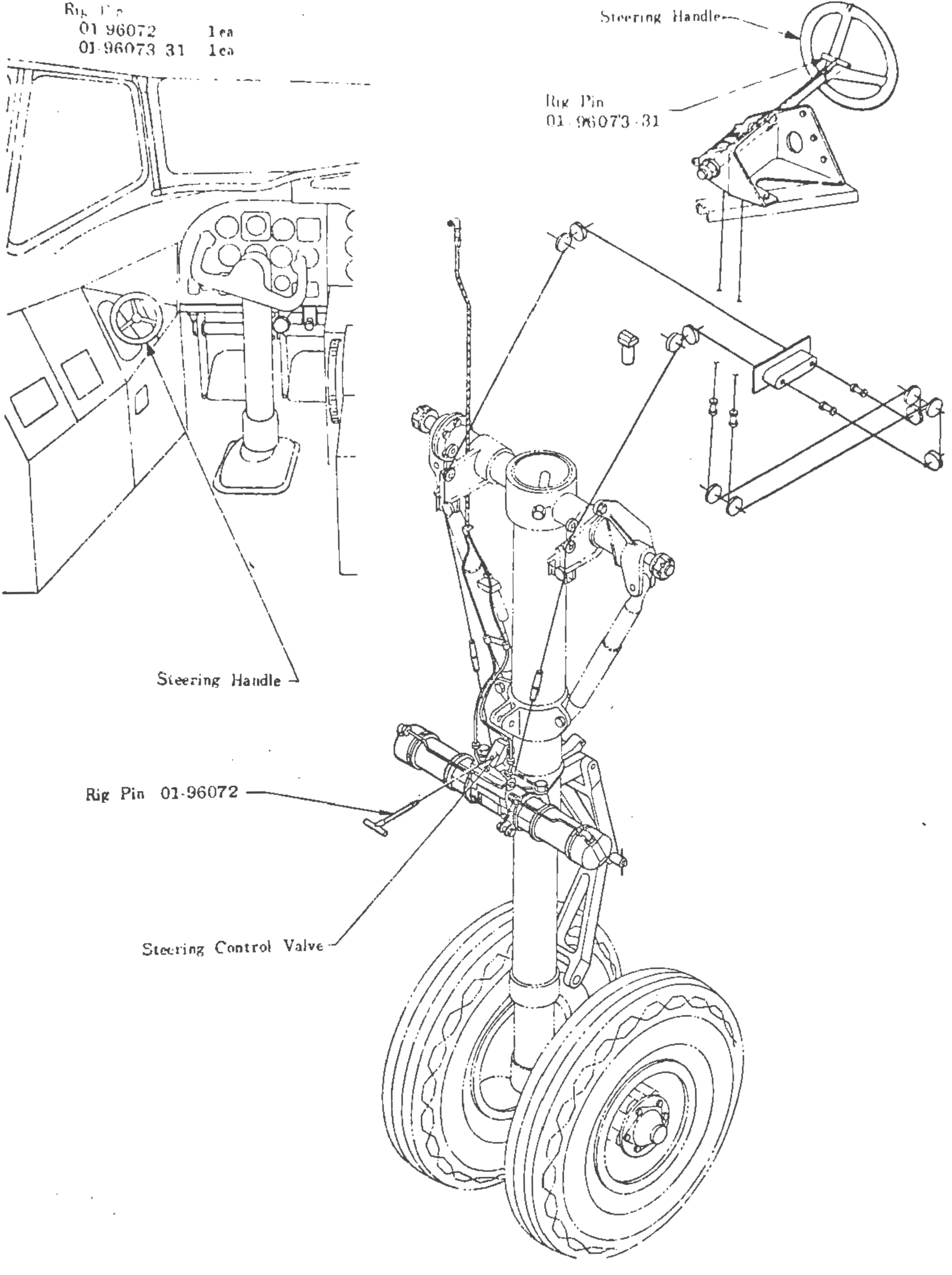


Figure 16–25

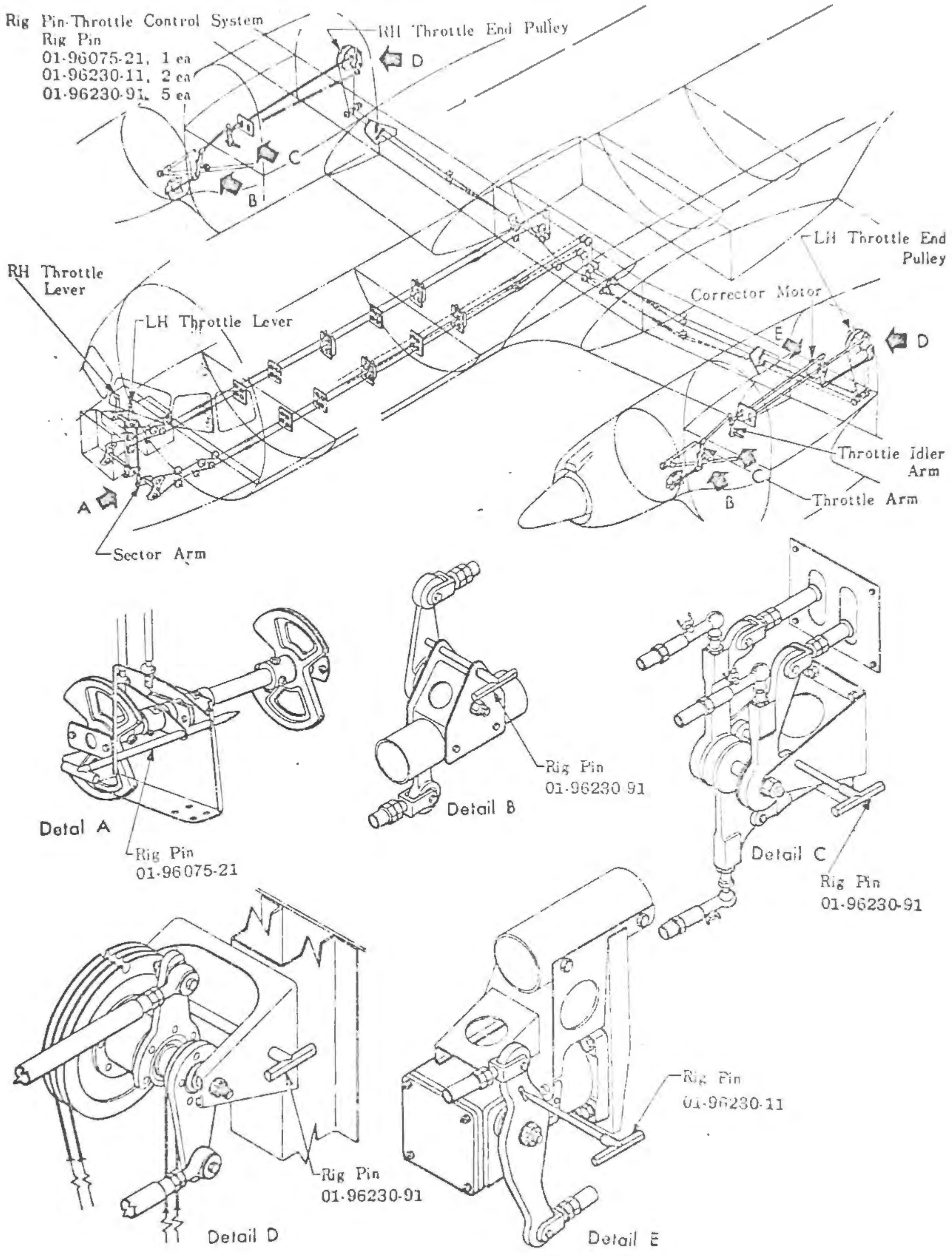

Rig Pin-Throttle Control System
Rig Pin
01-96075-21, 1 ea
01-96230-11, 2 ea
01-96230-91, 5 ea
RH Throttle End Pulley
D
C
B
RH Throttle Lever
LH Throttle Lever
LH Throttle End Pulley
Corrector Motor
E
D
Throttle Idler Arm
C
B
Throttle Arm
A
Sector Arm
Detail A
Rig Pin
01-96075-21
Rig Pin
01-96230 91
Detail B
Detail C
Rig Pin
01-96230-91
Rig Pin
01-96230-11
Rig Pin
01-96230-91
Detail D
Detail E

Figure 16-26

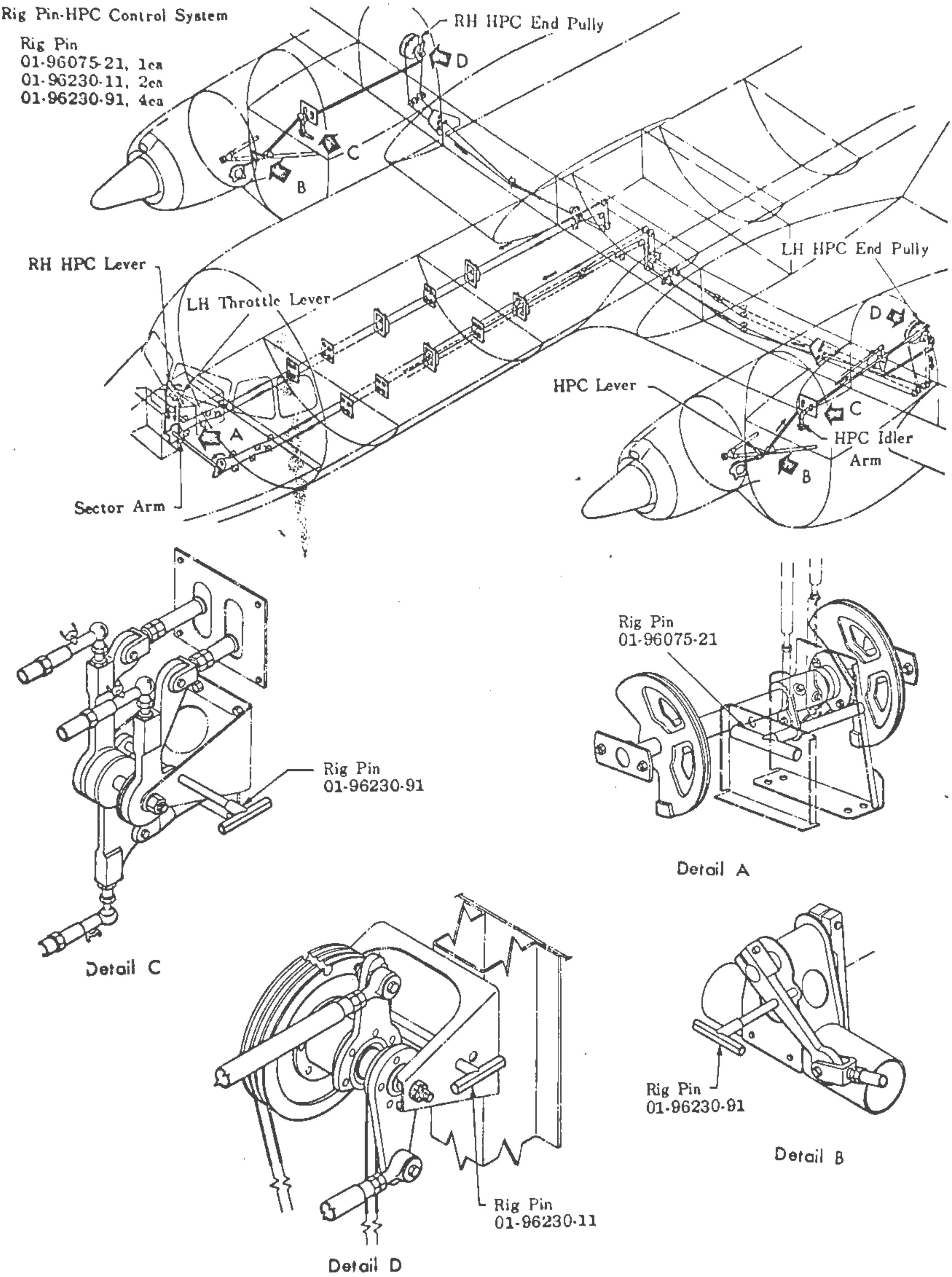
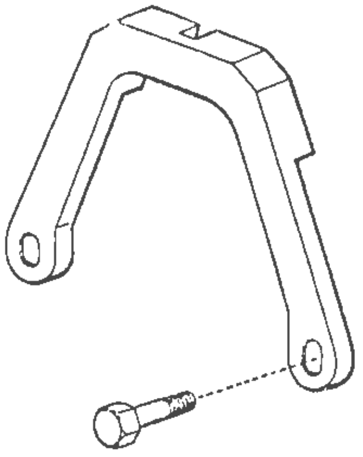
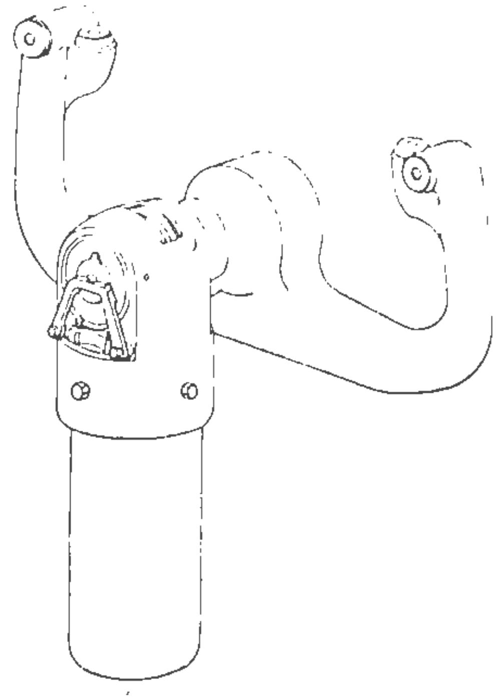

Rig Pin-HPC Control System
Rig Pin
01-96075-21, 1ea
01-96230-11, 2ea
01-96230-91, 4ea
RH HPC End Pully
D
C
B
RH HPC Lever
LH Throttle Lever
A
Sector Arm
LH HPC End Pully
D
HPC Lever
C
HPC Idler
Arm
B
Rig Pin
01-96075-21
Detail A
Rig Pin
01-96230-91
Detail C
Rig Pin
01-96230-91
Detail B
Rig Pin
01-96230-11
Detail D

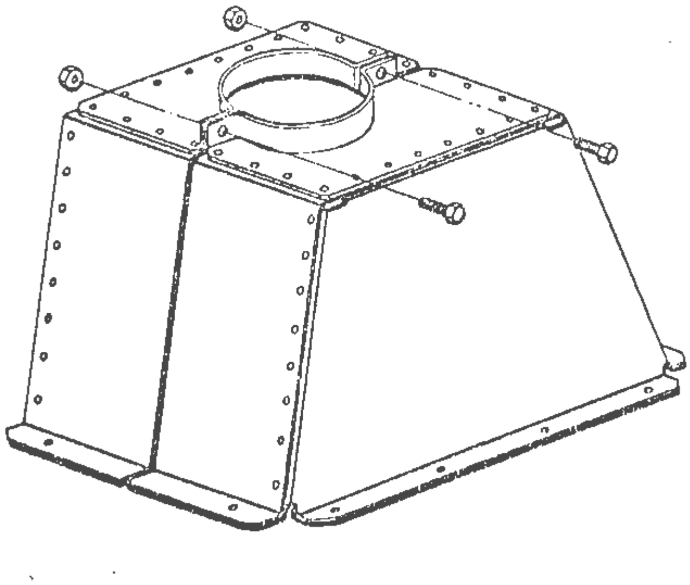
Figure 16–27

01-96101 Rigging Tool-Control Wheel
USE: To lock the control wheel in the neutral position during adjustment of the aileron control system.





01-96107 Rigging Tool-Control Column
USE: To fix the control column during adjustment of elevator and aileron control systems.



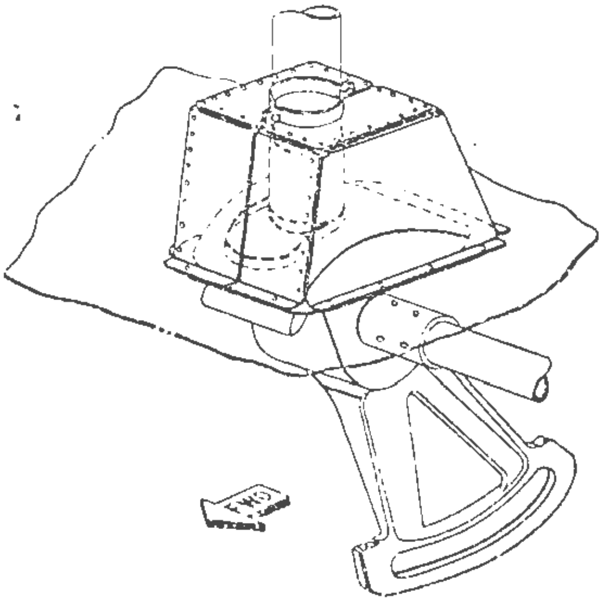
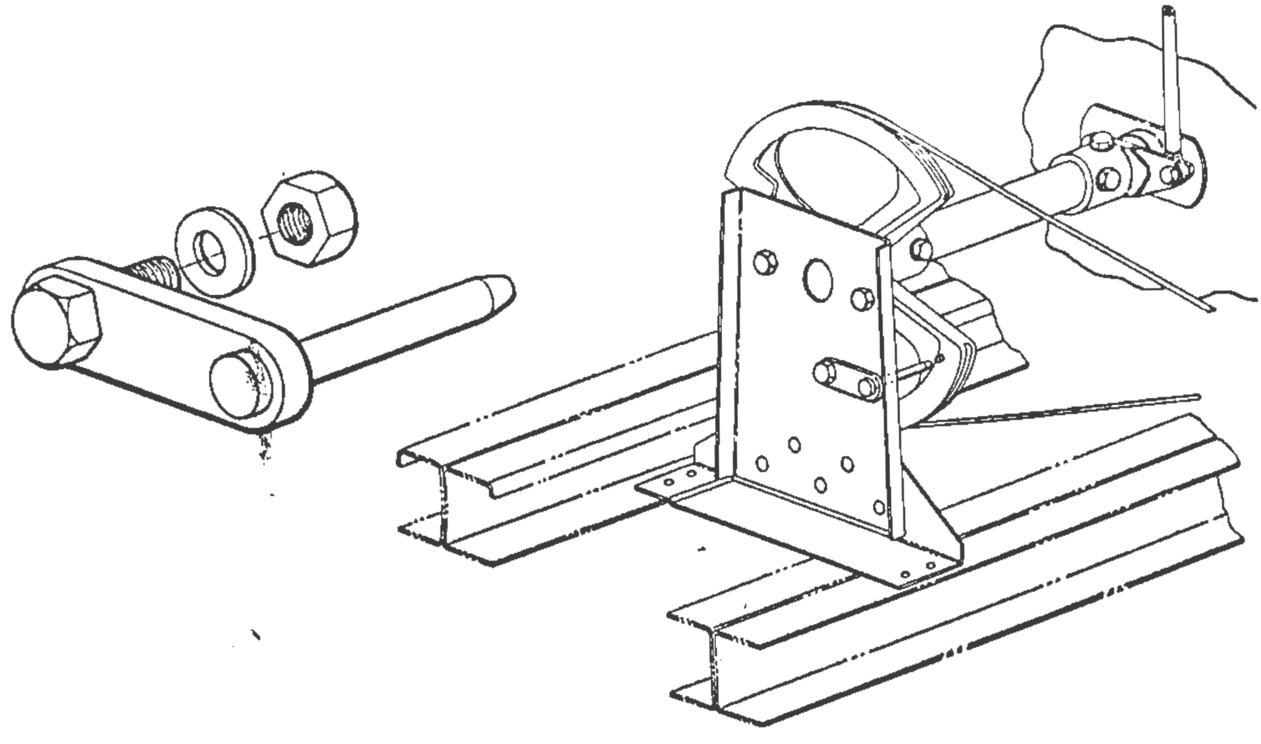


Figure 16–28

01·96104 Rigging Tool·Gust Lock Sector
USE; To fix the sector located at the forward fuselage dring adjustment of gust lock system.
(See Maintenance Manual 27·70·0 Fig 501)



01·96240·1 Check Gauge·Aileron (LH)
01·96240·2 Check Gauge·Aileron (RH)

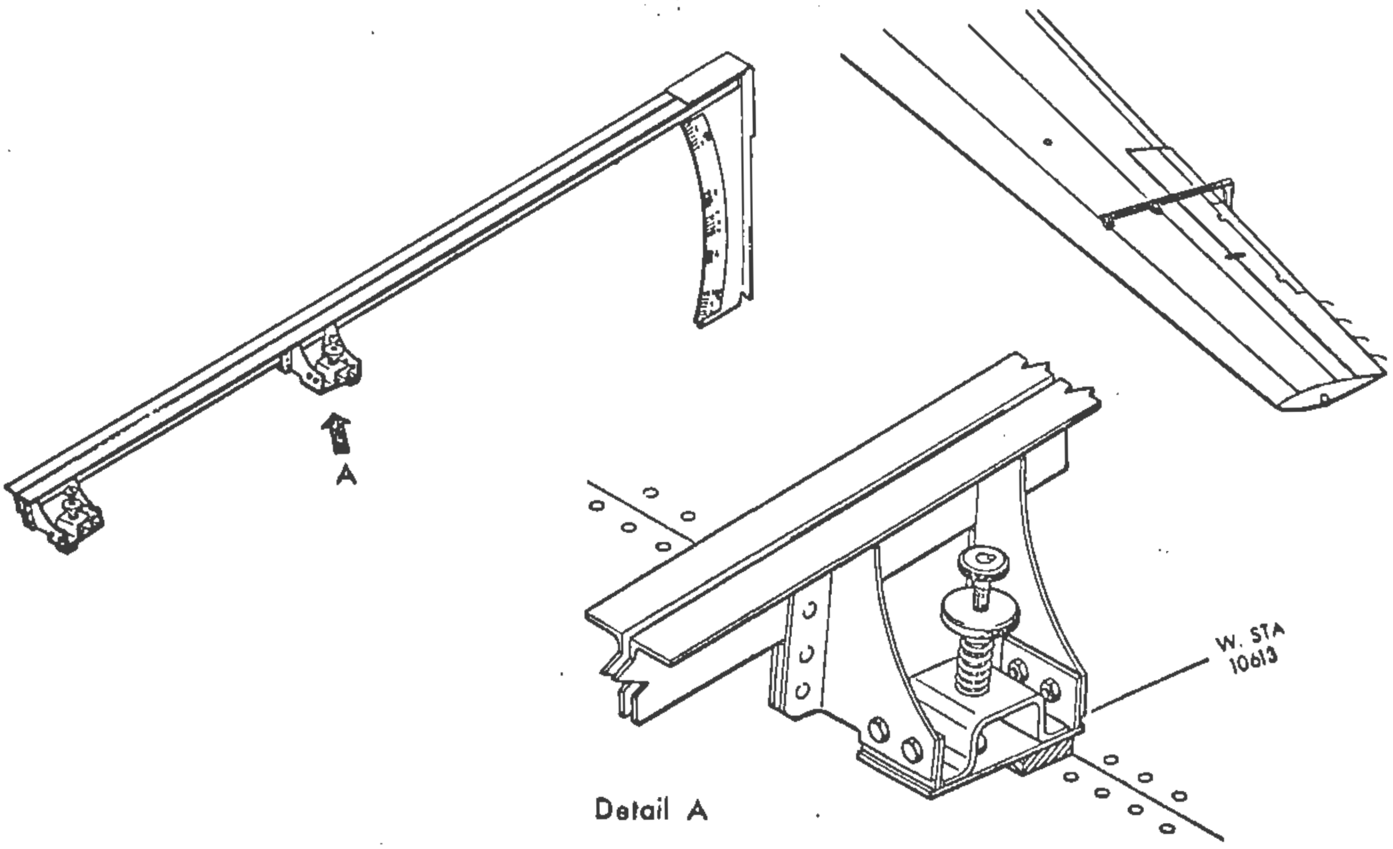
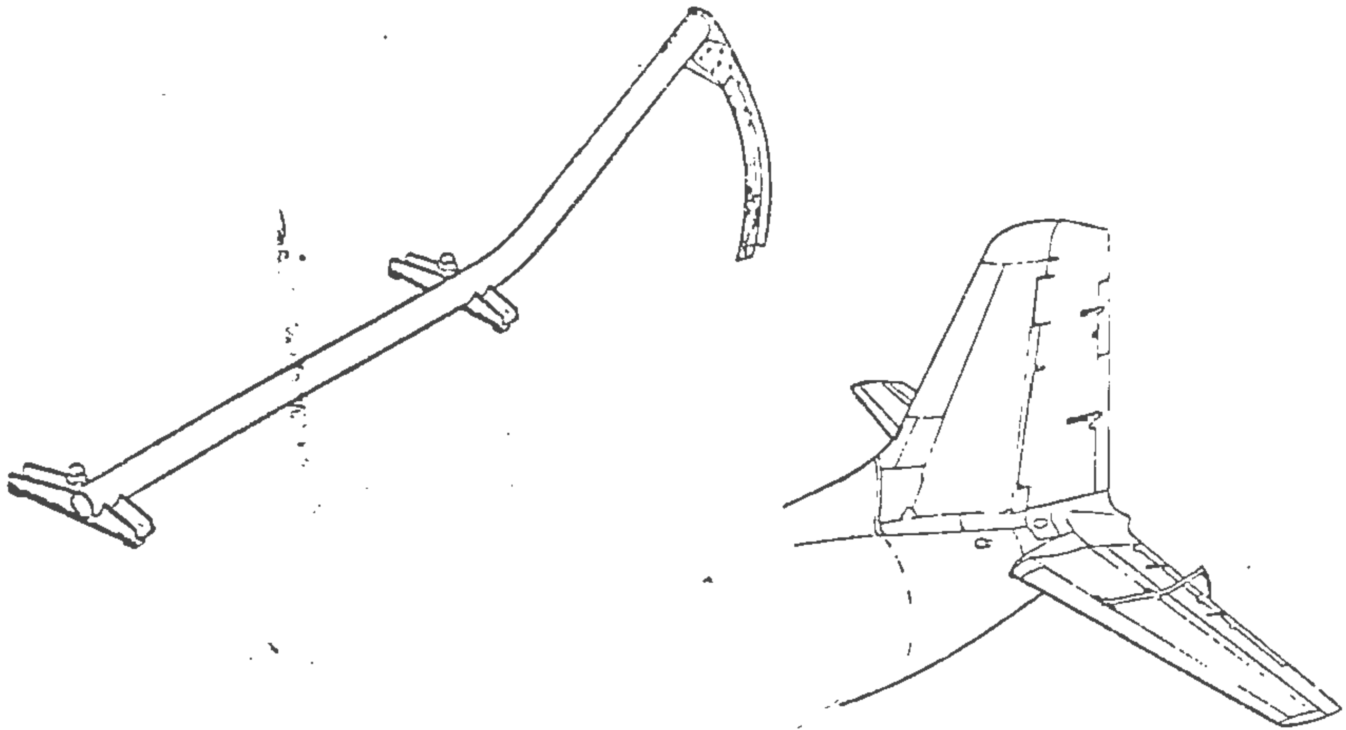


Figure 16—29

01-96627-1 Check Gauge-Elevator LH
01-96627-2 Check Gauge-Elevator RH



01-96618 Check Gauge-Rudder

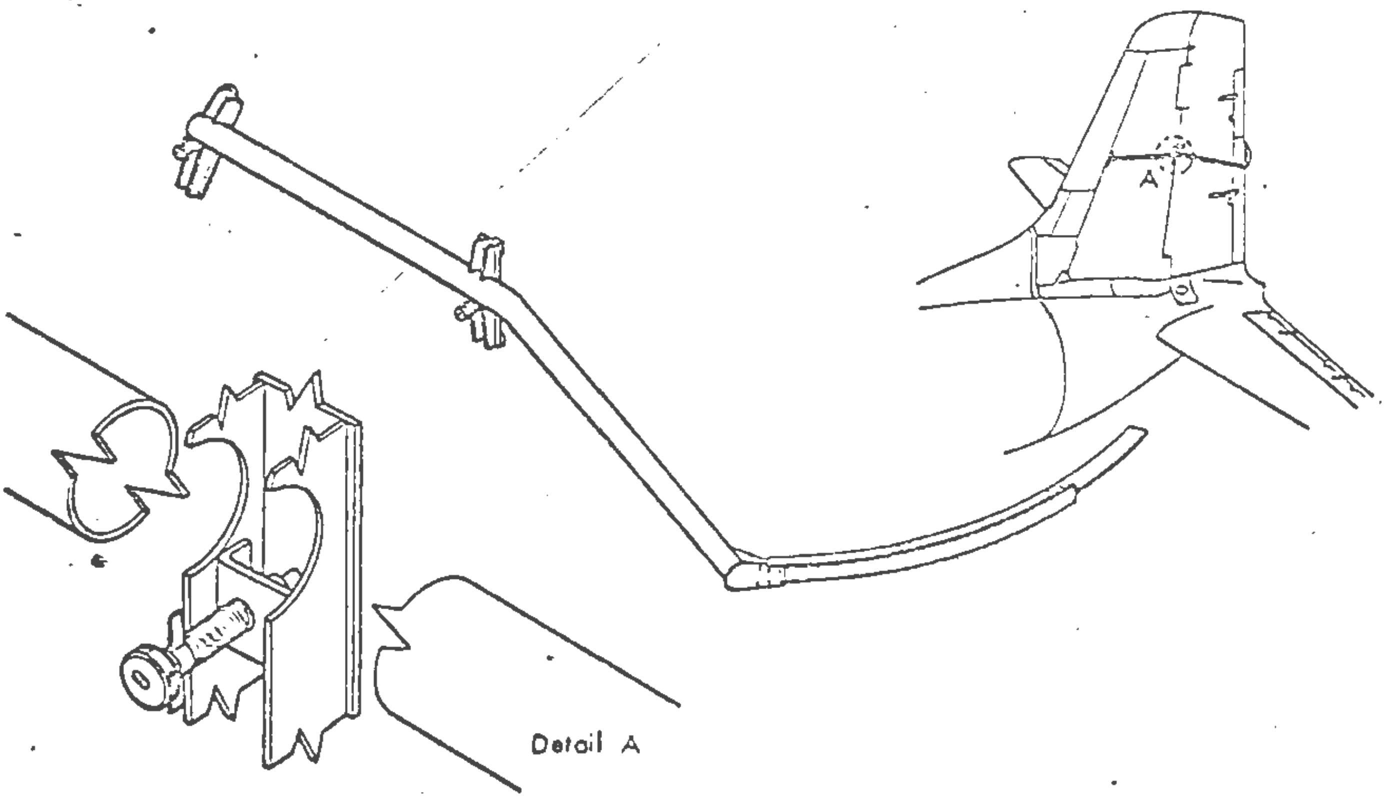
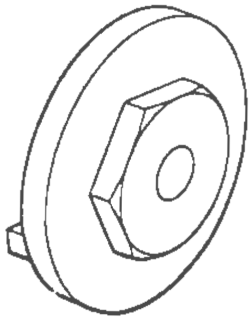
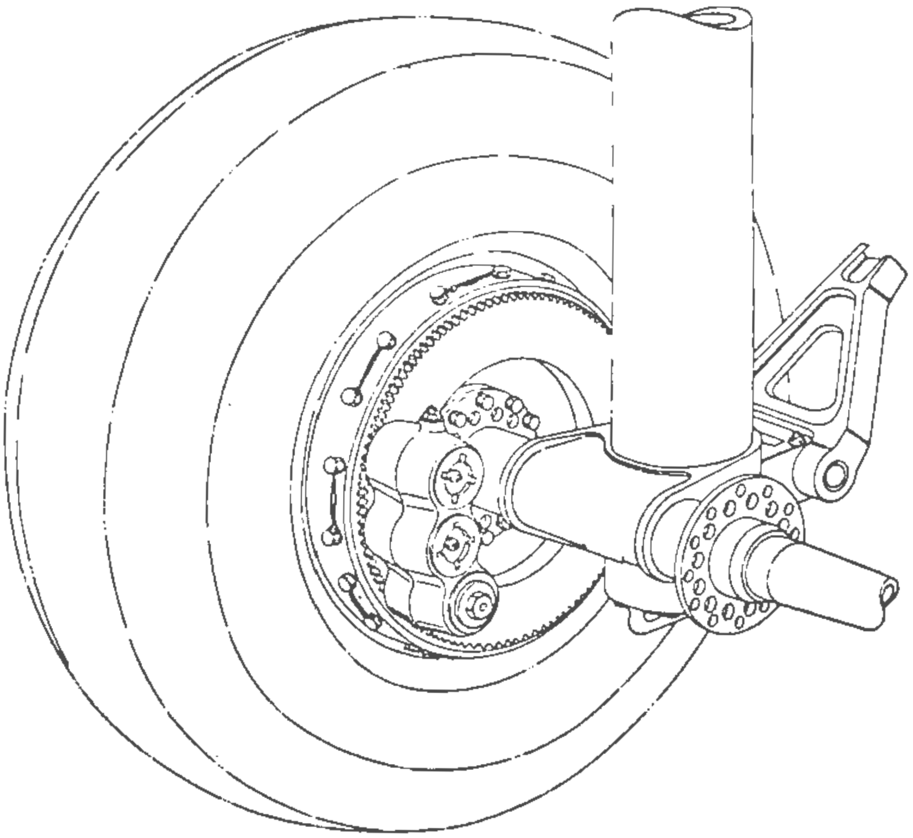


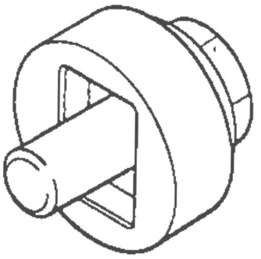
Figure 16-30

01-96150 Wrench Adapter-Brake Cylinder
USE; For adjustment of main landing gear brake cylinder.





01-96250 Wrench Adapter-Main Landing Gear Installation
USE; For installation of the main landing gear attaching pin.



Detail A

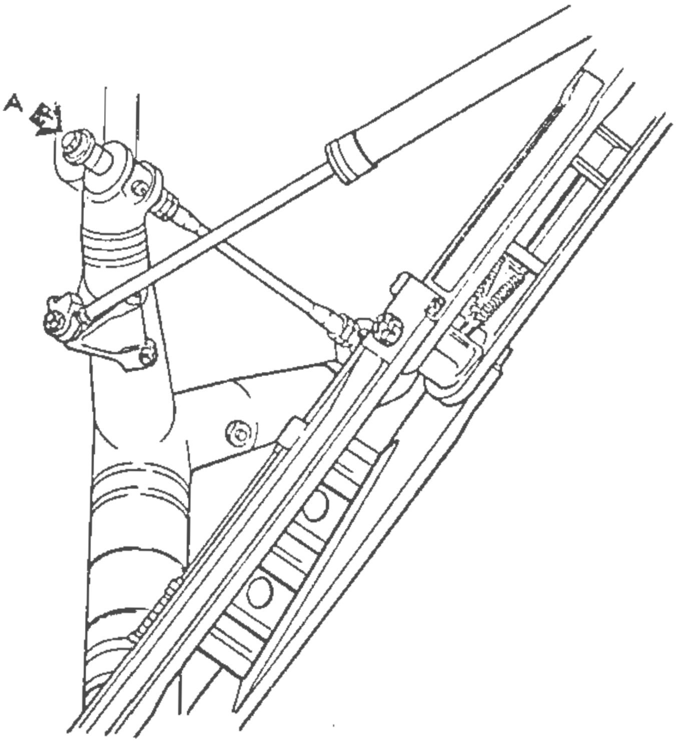
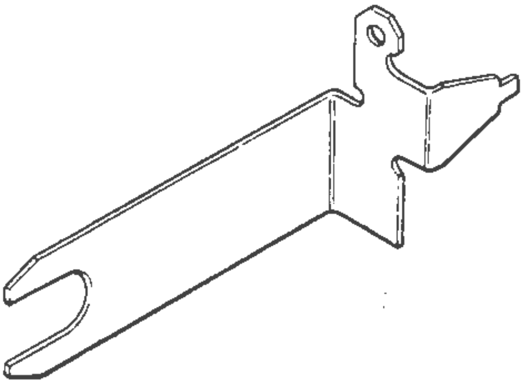


Figure 16–33

01 96214 Locking Plate-Corector Moter
USE: To lock the corrector moter when rigging.



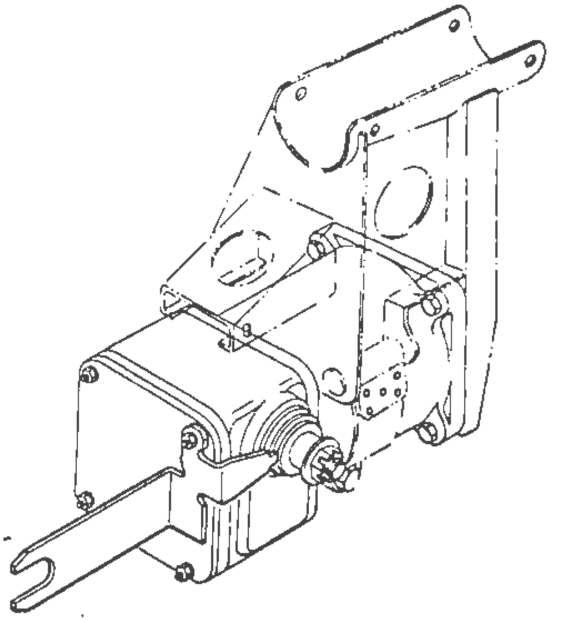
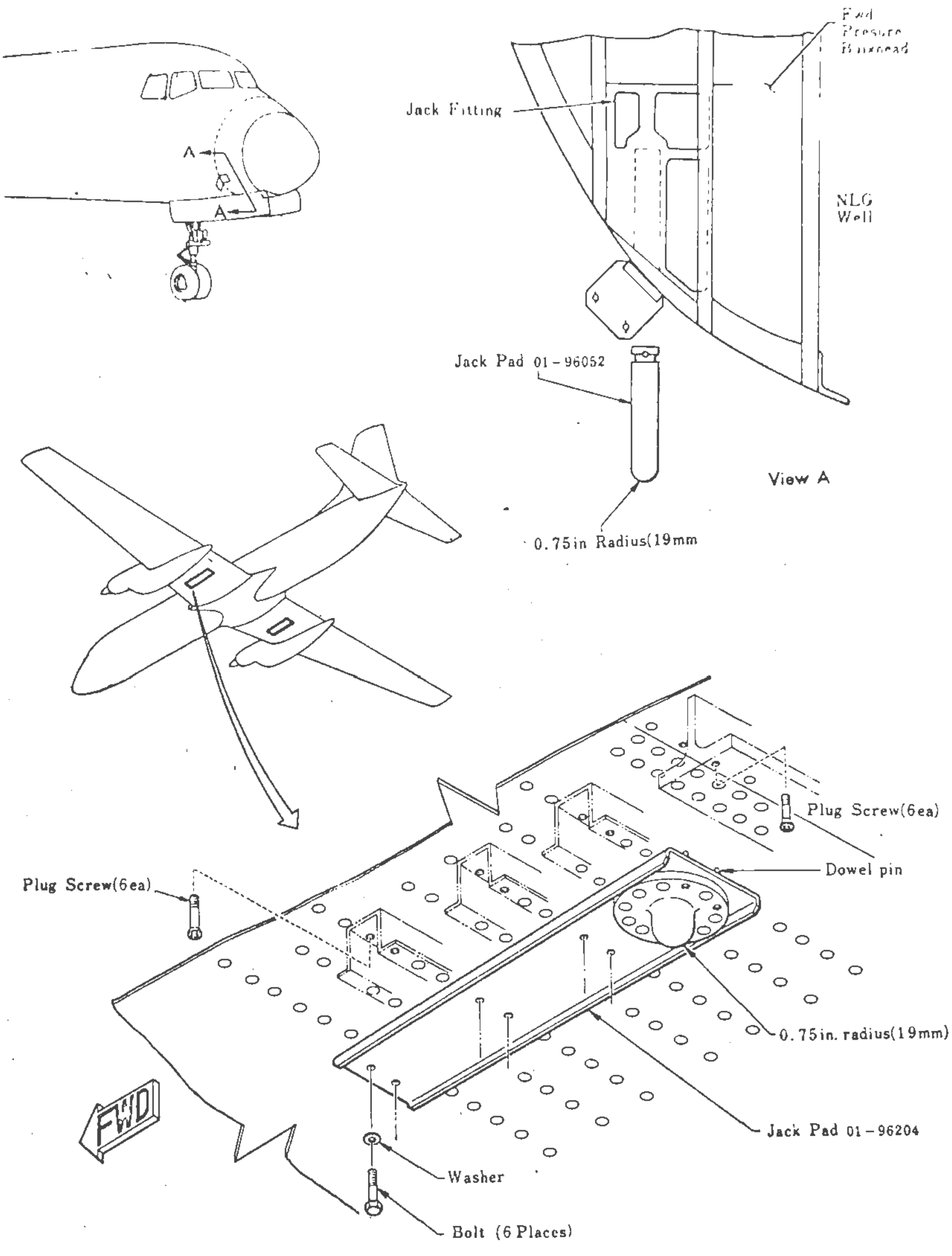
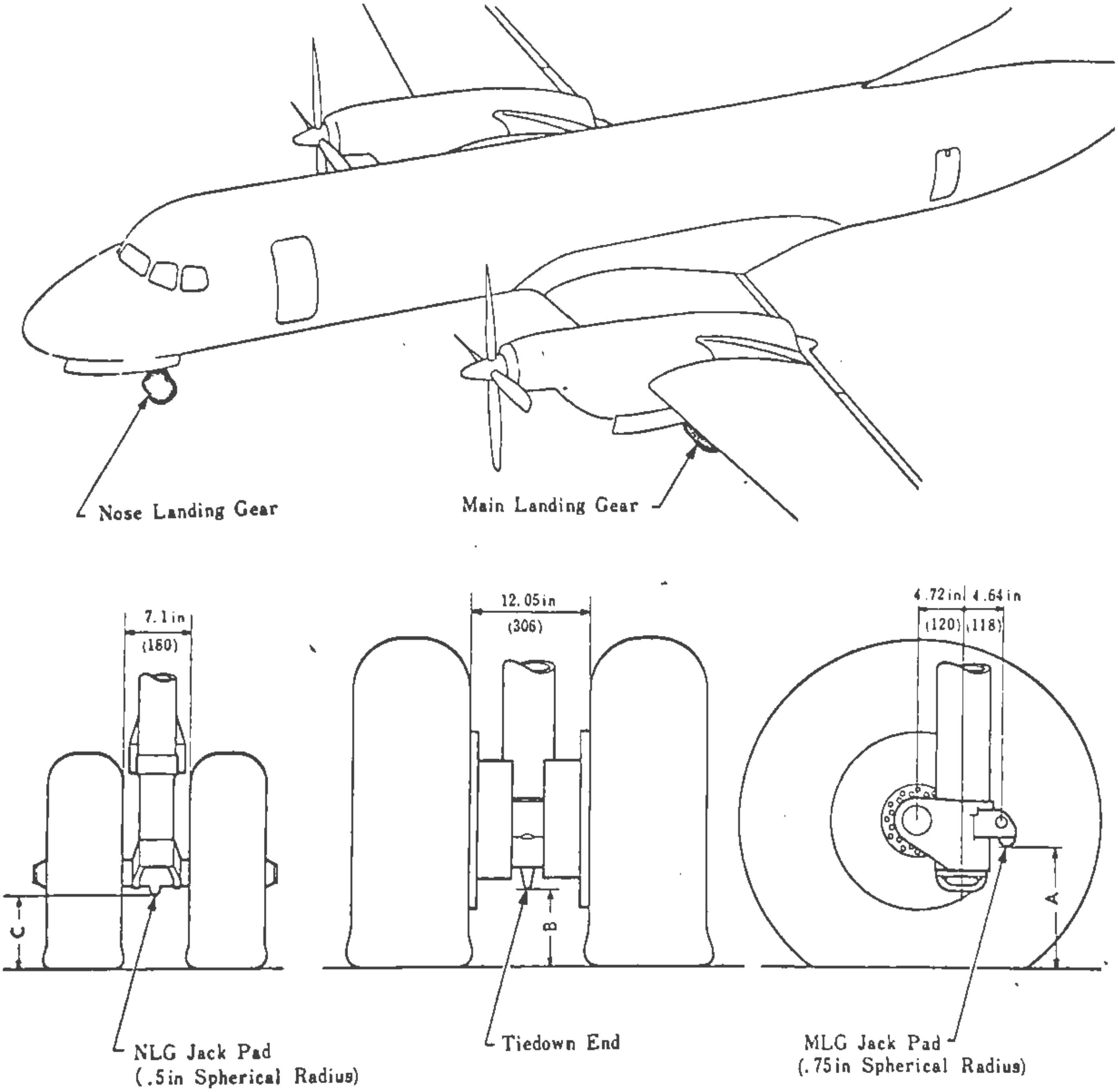


Figure 16–35



Jacking Points
Figure 16–37

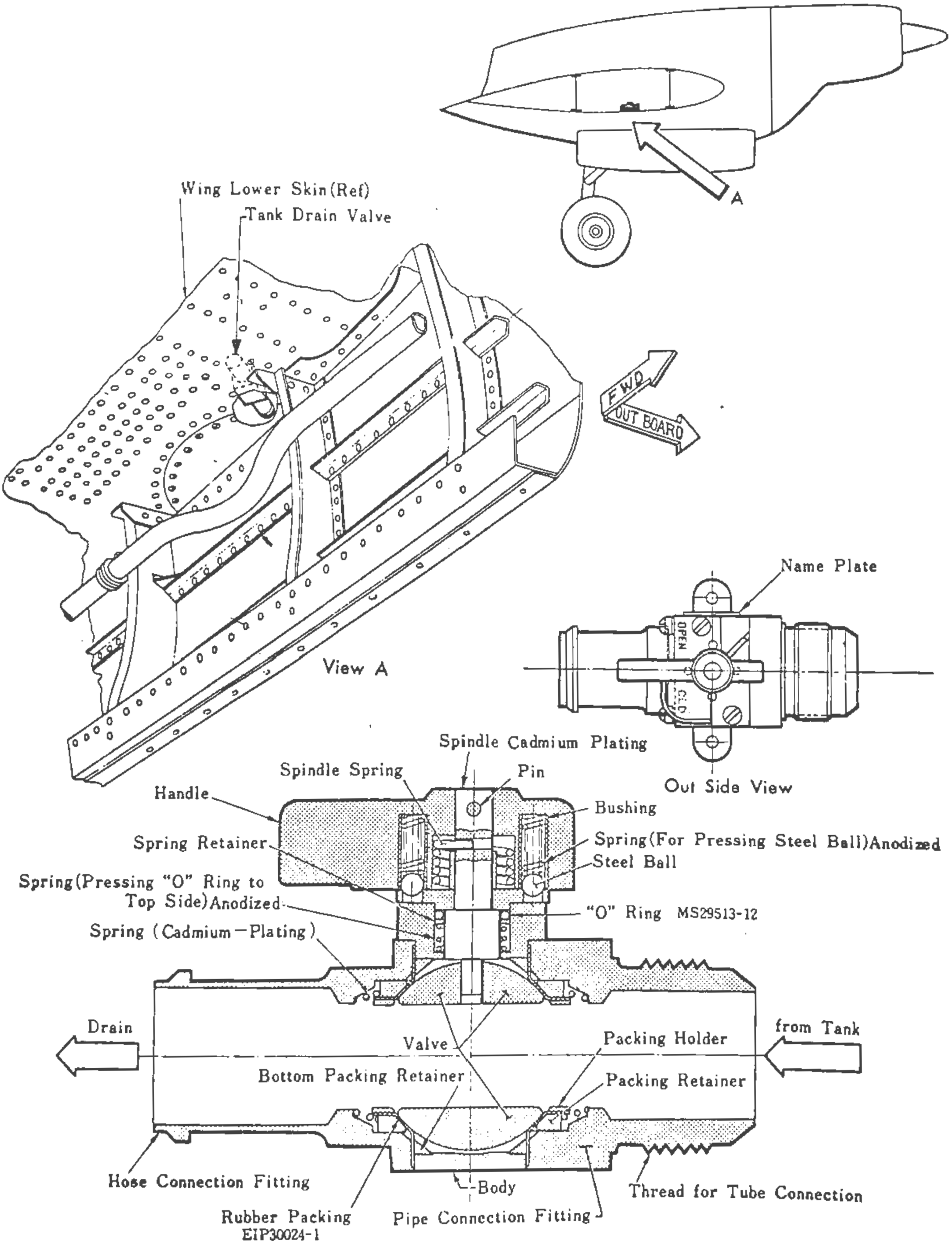


JACK CLEARANCES AND LOADS					
DIM		TIRES INFLATED	ONE TIRE FLAT	TIRES FLAT	LOAD
MAIN LANDING GEAR	A	16.9in (429)	10.91in (277)	8.6in (218)	10,000kg (EACH)
	B	12.1in (307)	6.1in (155)	3.7in (94)	
NOSE LANDING GEAR	C	10.2in (259)	6.81in (173)	4.93in (125)	2.000kg

Note:Dimensions in Brokets are shown in Millimeters

Jacking — Landing Gear

Figure 16–38

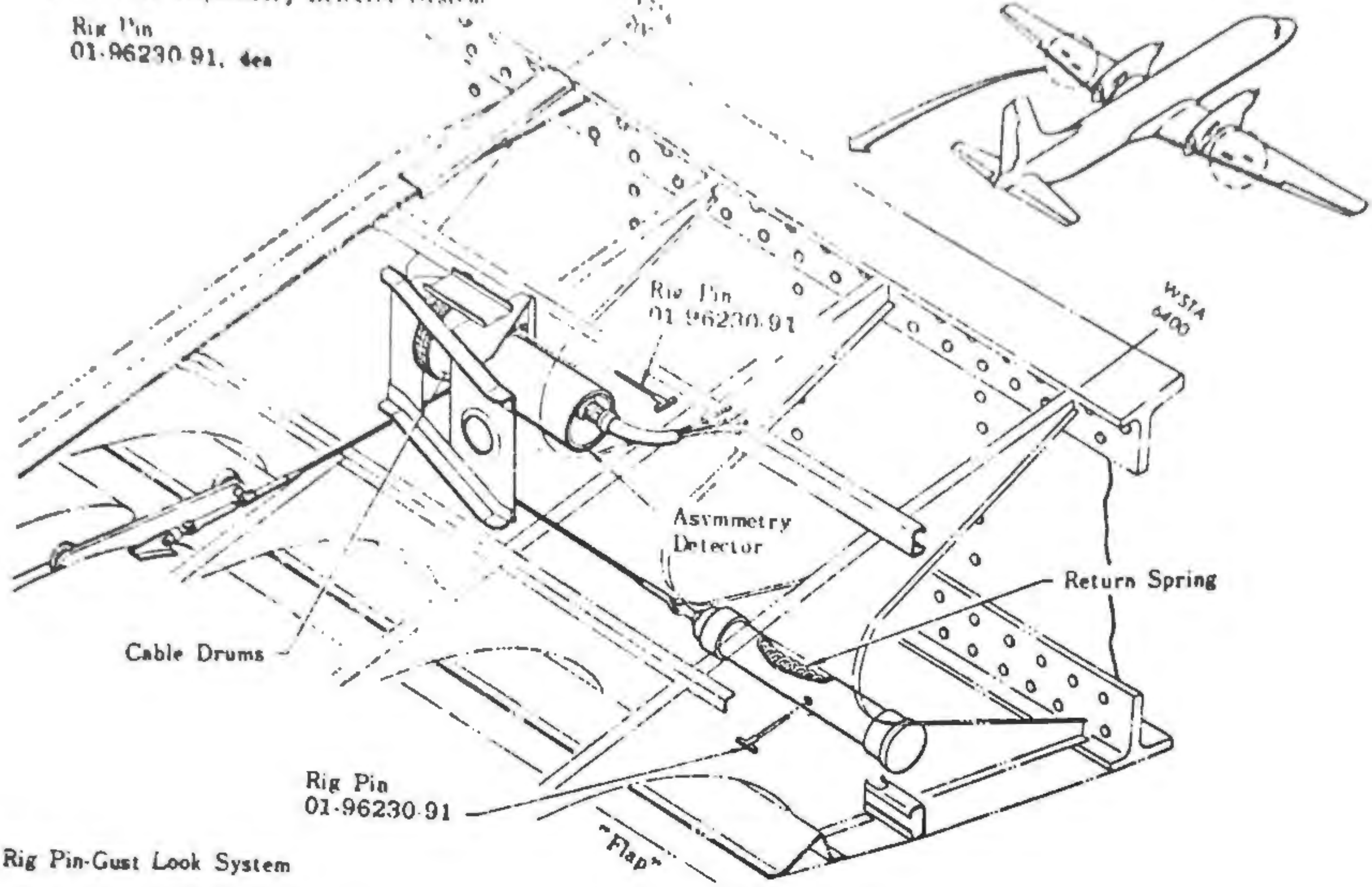


Section View

Fuel Tank Drain Valve

Figure 5—28

Rig Pin-Flap Asymmetry Detector System



Rig Pin-Gust Look System

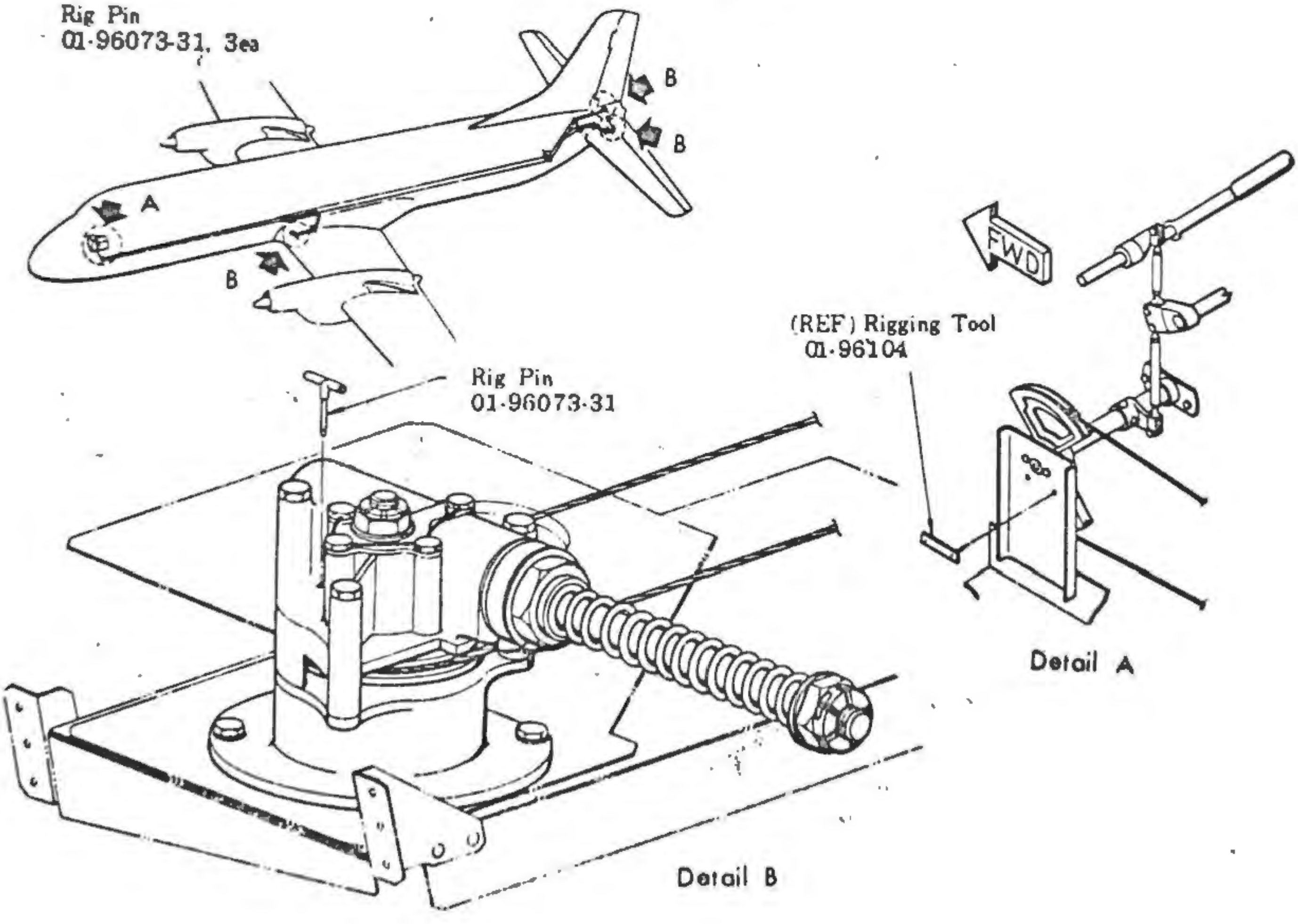


Figure 16-21

01-97001 Protractor
USE: To measure the travel of the aileron, rudder and flap.

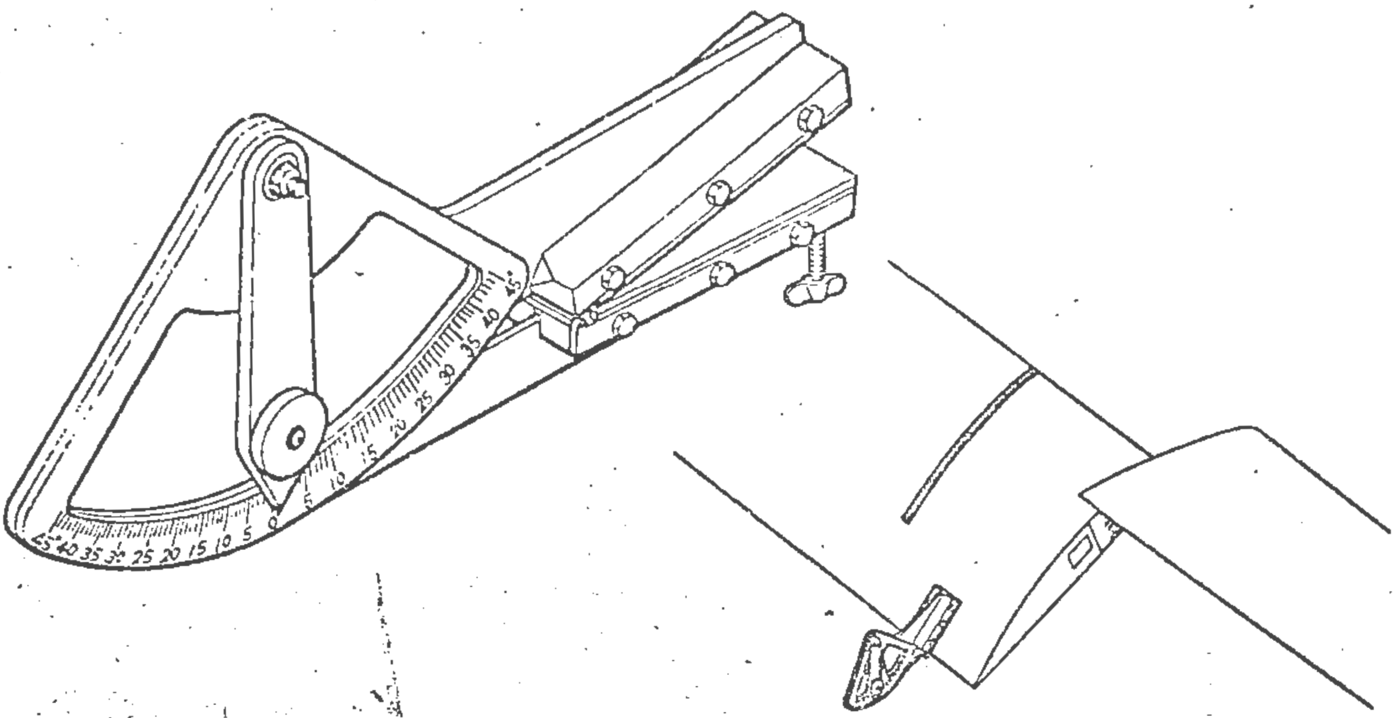
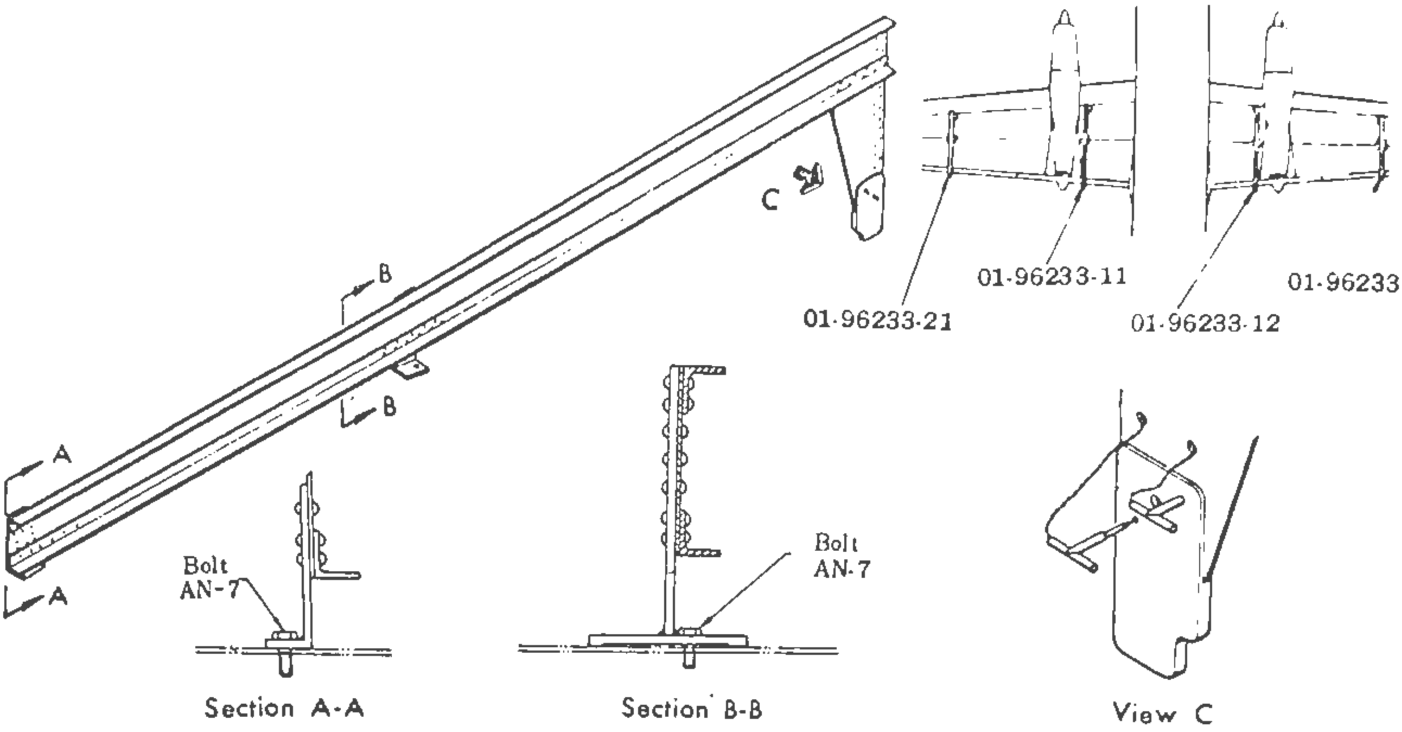


Figure 16–31

01-96233-11	Check Gauge-0°LH Innerflap at W. STA 1800
01-96233-12	Check Gauge-0°RH Innerflap at W. STA 1800
01-96233-21	Check Gauge-0°LH Outerflap at W. STA 7200
01-96233-22	Check Gauge-0°RH Outerflap at W STA 7200

USE: To check the up position of the inner and outher flap.



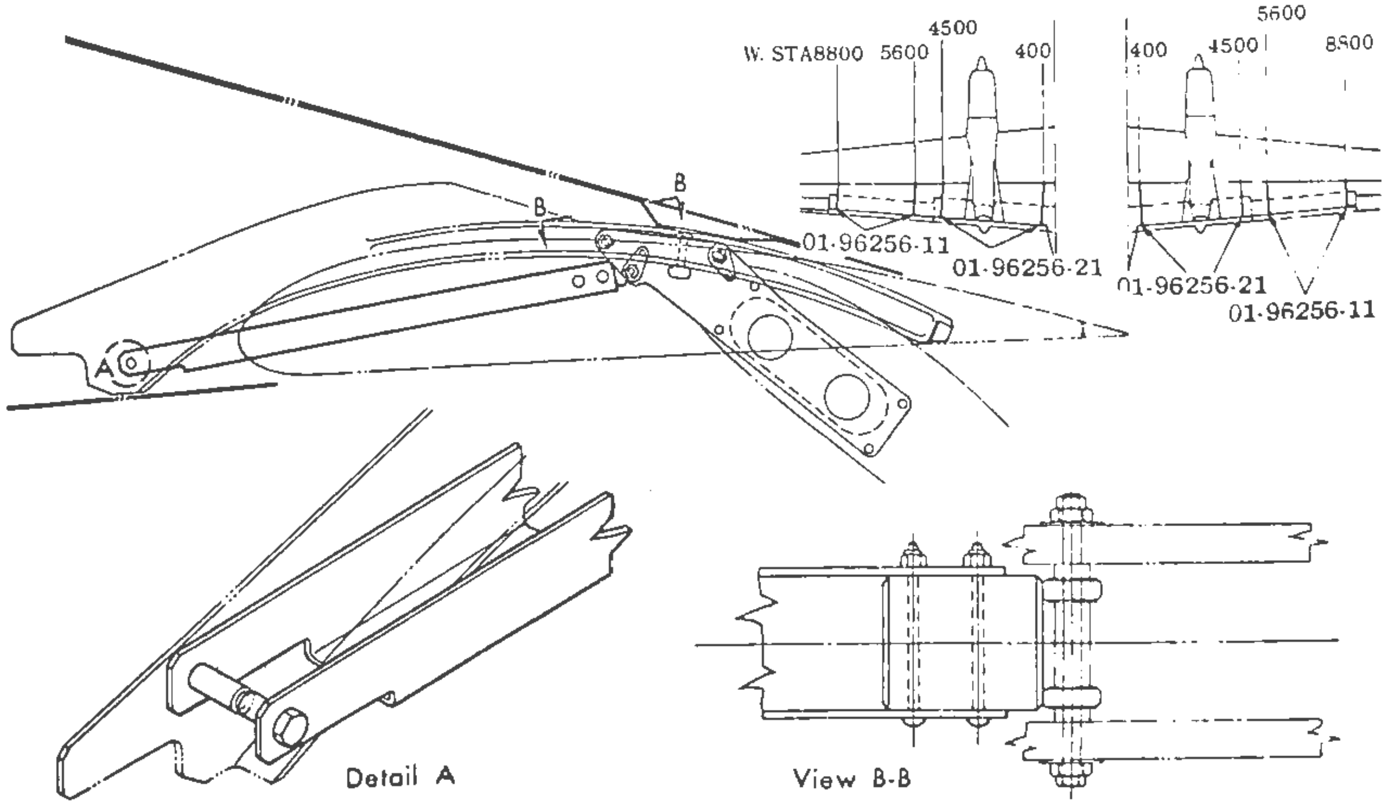
Section A-A

Section B-B

View C

01-96256-11	Check Gauge-35° Outerflap
01-96256-21	Check Gauge-35° Innerflap

USE: To check the 35° down position of the inner and outerflap.

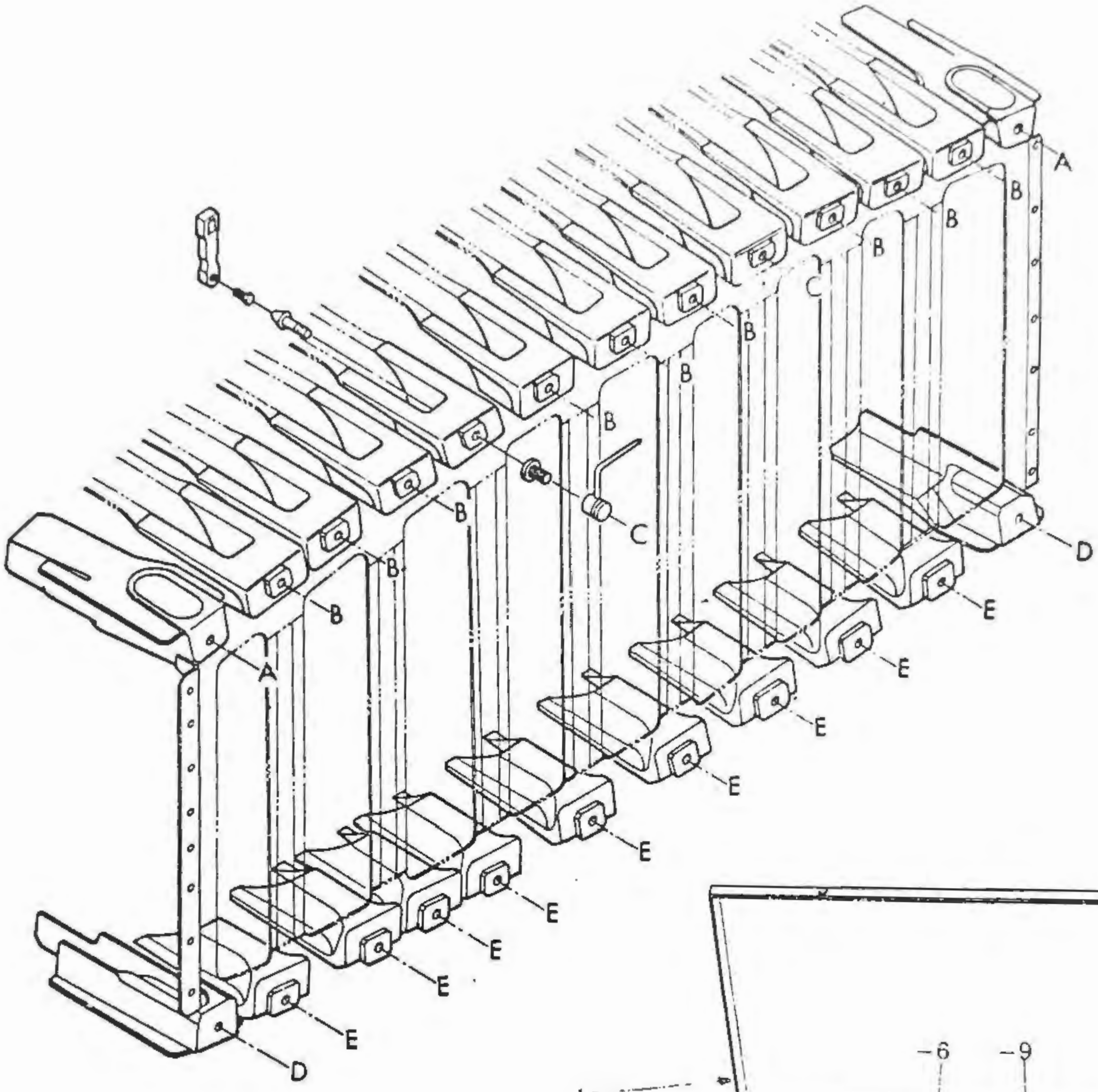


Detail A

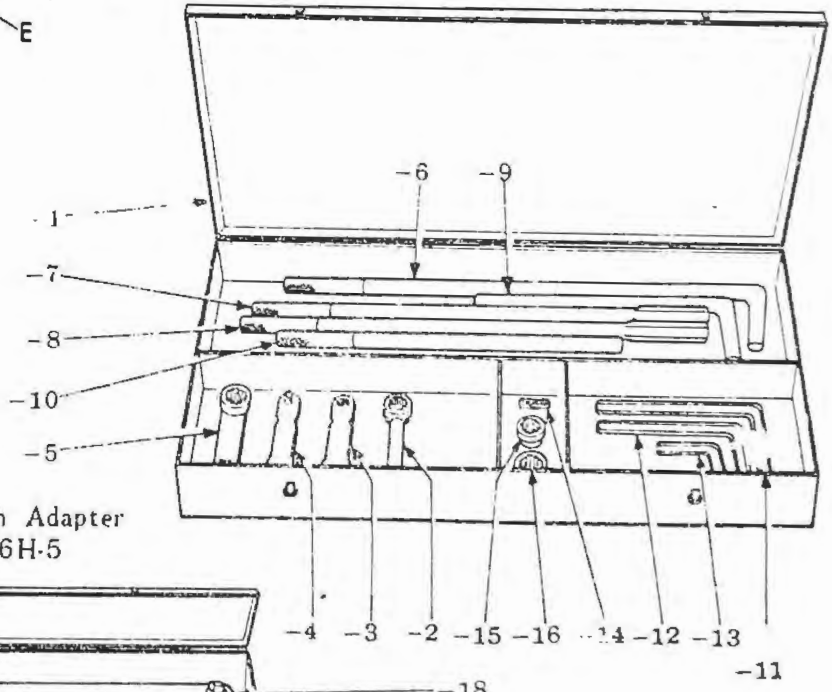
View B-B

Figure 16–32

01-00101-26H-5 Torque Wrench Adapter-Attaching Bolt Center-Outer Wing
USE: For installation and removal of the outer wing



	Wrench or Adapter
A	01-00101-26H-5-3
	01-00101-26H-5-4
	01-00101-26H-5-14
B	01-00101-26H-5-4
	01-00101-26H-5-13
C	01-00101-26H-5-2
	01-00101-26H-5-3
	01-00101-26H-5-14
D	01-00101-26H-5-5
	01-00101-26H-5-11
E	01-00101-26H-5-4
	01-00101-26H-5-12



Torque Wrench Adapter
01-00101-26H-5

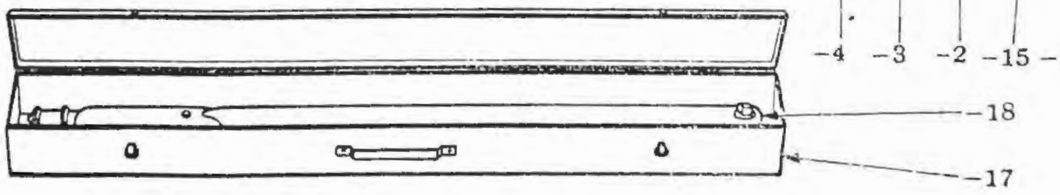


Figure 16–34

16.2 Lifting

The lifting procedures are described below to facilitate maintenance and inspections of the aircraft components at the time of the maintenance and overhauls.

16.2.1 Lifting of Entire Aircraft

The entire aircraft can not be lifted since hoisting points for this purpose are not provided.

16.2.2 Lifting of Outer Wing

The outer wing without the engine, propeller, gear box, engine cowling and fuel can be lifted with the outer wing sling attached to the hoisting points at WS7200 and WS1800. Its weight is approximately 5500 lb (2500 Kg).

16.2.3 Lifting of Vertical Wing

The vertical wing weighing approximately 550 lb (250 Kg), can be lifted with a sling attached to the hoisting points provided on the L.H. and R.H. sides of the upper part of the vertical tail.

16.2.4 Lifting of Horizontal Tail

The horizontal tail with the elevators weighs approximately 800 lb (350 Kg) and the horizontal stabilizer only weighs approximately 550 lb (250 Kg). The lifting sling is attached to a long tie plate which is installed in place of the tail plate.

16.2.5 Lifting of Engine

The engine or the QEC kit can be lifted with P/N J54595/1 or P/N GZ02036/1.

When the former is used, the engine without the propeller or QEC only can be lifted. When the latter is used, the engine with the propeller or the removed engine only can be lifted.

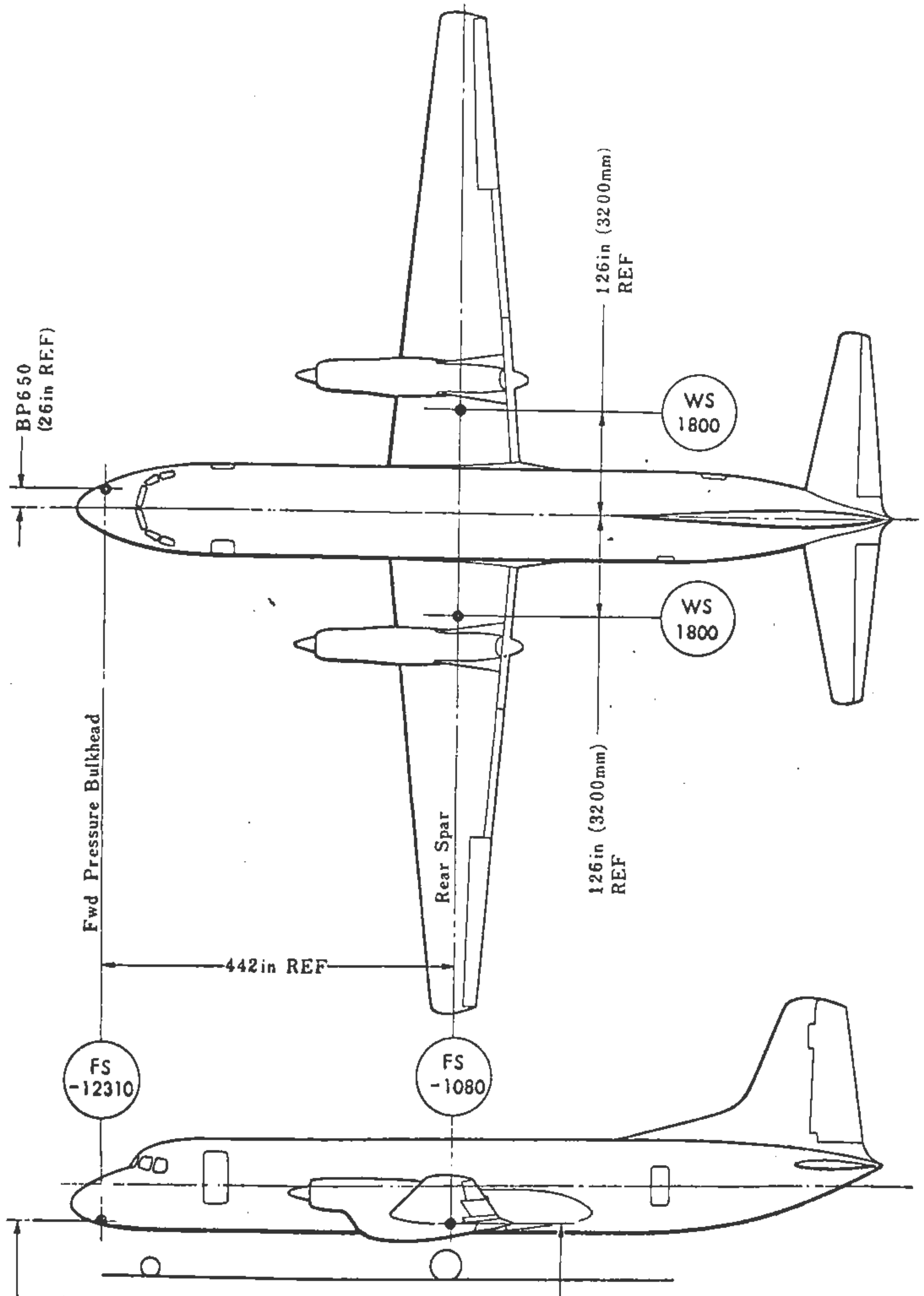
The QEC kit weighs approximately 1650 lb (750 Kg) and the engine with the propeller weighs approximately 2350 lb (1060 Kg).

16.3 Jacking

The procedures for aircraft jacking are described below to facilitate the landing gear operation on the ground, levelling and measurement of the center of gravity.

16.3.1 Aircraft Jacking

The aircraft can be jacked up at three points, 1 ea. on the lower surface of the rear spar at WS1800 of the L.H. and R.H. wings and one on the lower R.H. side of the forward pressure bulkhead at FS-12310.



① Struts fully extended

② Struts fully compressed and Tires flat

Jacking Dimension

Figure 16–36

Precautions

(1) The aircraft shall be jacked up on a flat place and in a head wind when the aircraft is jacked up outdoors. The aircraft shall not be jacked up when gusts in excess of 20 Mil/H or 9 m/s are prevailing.

(2) Before the aircraft is jacked up, fix the movable items aboard or see to it that safety hazards are eliminated.

(3) When the aircraft is tail-heavy or the engines have been removed from the aircraft, be sure to install the tail stand. Never apply force to the mooring point on the tail.

(4) Operate the jacks so that the aircraft can be maintained level.

(5) When the aircraft jacked up is lowered, remove all obstacles under the aircraft and put the safety pins in the landing gear.

16.3.2 Jacking Up of Landing Gear

When the tires or brakes are replaced, the landing gear is jacked up with a jack at the jacking point provided on the lower surface of the nose gear or main gear.

16.4 Levelling

The aircraft can be levelled by means of a level or levelling points.

(1) Levelling by Means of Level

The aircraft is jacked up until each tire is 1 in. above the floor. Place the level on the lugs located in the forward part or on the L.H. wall of the nose gear compartment for levelling.

(2) Levelling by Means of Levelling Points

The levelling points are provided on the L.H. and R.H. sides of the fuselage at WP 0, -10100 and +8000 and the aircraft can be levelled longitudinally or laterally by means of a transit.

16.5 Towing

The aircraft can be towed with a towing bar fixed to the nose gear, not depending on the aircraft power. The aircraft also can be towed with ropes tied to the main gear if necessary.

16.6 Taxiing

The direction of the aircraft during taxiing or running can be changed by means of the steering system. For details, see Chapter 6, HYDRAULIC SYSTEM.

16.7 Parking

When the aircraft is parked, observe the following precautions:

(1) Keep sufficient distances between the aircraft and the others.

(2) Place the aircraft in a head wind.

(3) Put the gust lock on.

(4) Apply the parking brake.

(5) Ground the aircraft.

(6) Put the wheel chocks in place.

(7) Put the landing gear safety pins in place.

16.8 Mooring

The aircraft is moored when it is parked outdoors for a long time or when the weather is bad.

Precautions

(1) Turn off the battery switch. Remove the batteries from the aircraft, if possible.

(2) Cover the exposed points with the applicable ground equipment.

(3) Rotate the contact surfaces of the tires at every 48 hours.

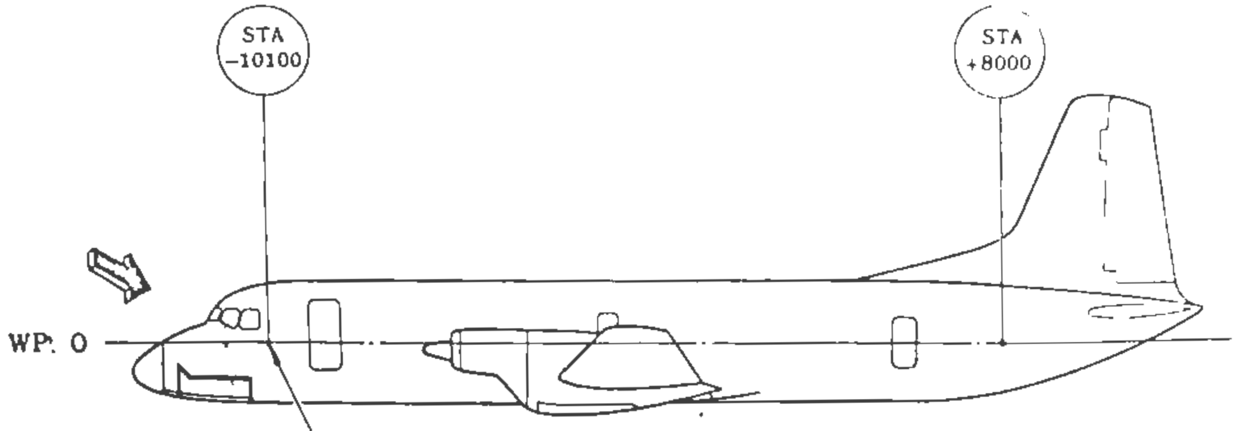
(4) If icing is feared, lay matting or dry sands approximately 1/2 in. thick under the contact surfaces of the tires.

16.9 Washing

Before the aircraft is washed, close and seal with tape the doors, access holes, covers etc. which water is likely to enter, to prevent water from entering the inside after washing, damaging the furnishing and functional parts.

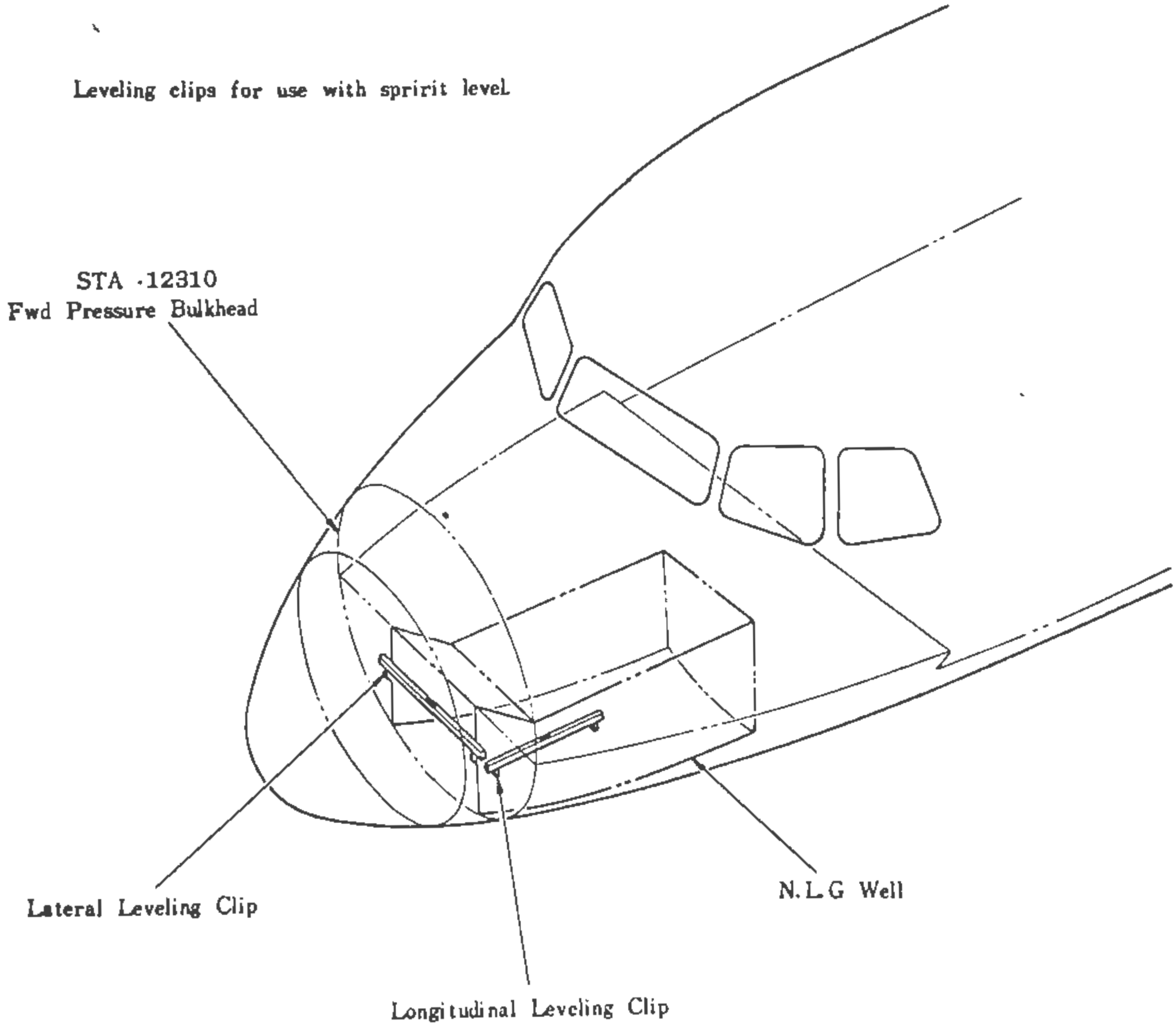
16.10 Lubrication

The rubbing parts are lubricated at the periodic checks to keep them well lubricated.

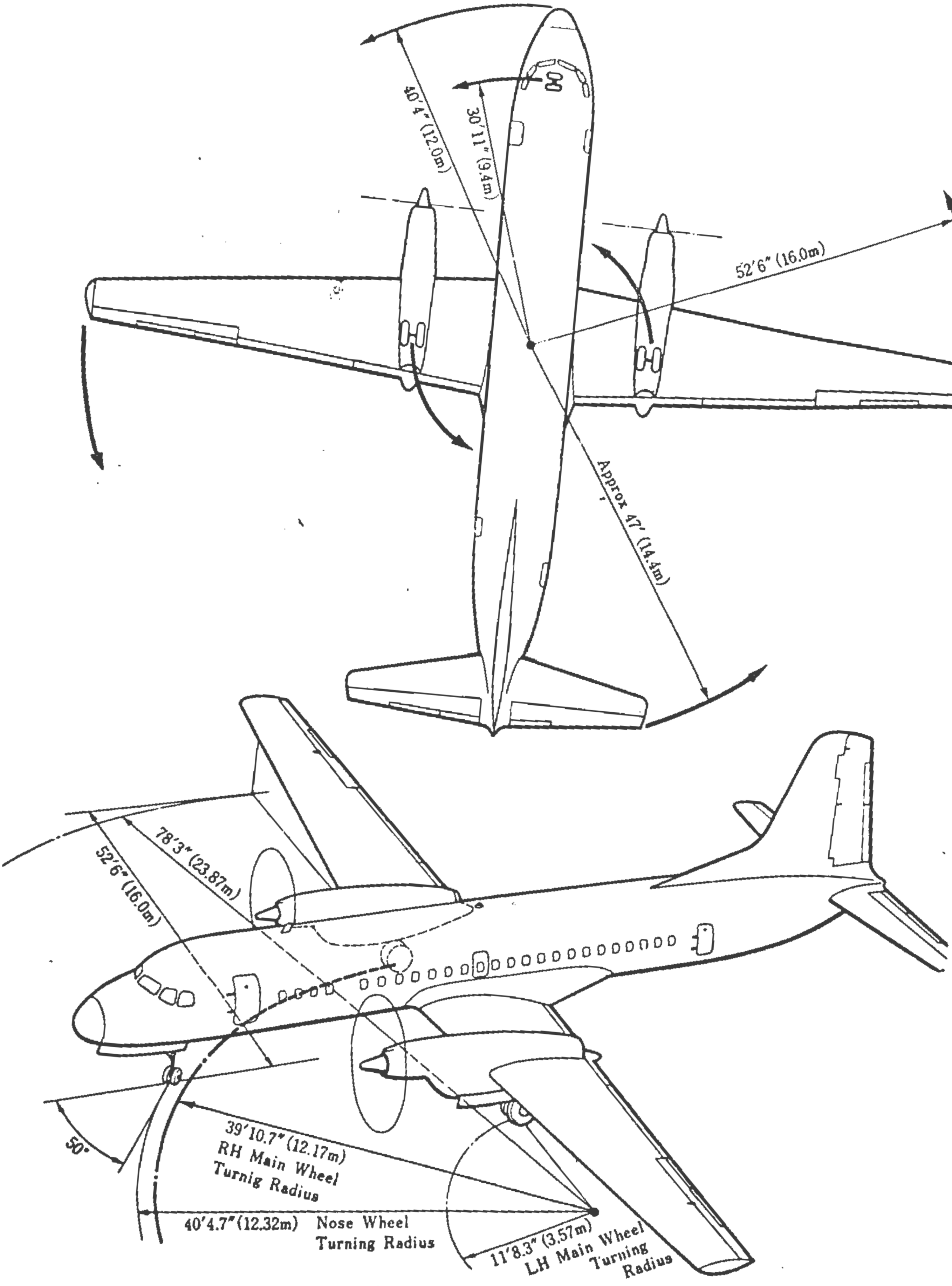


MS 20470 AD3 Rivet
2Places on each side of fuselage
for use with transit for leveling.

Leveling clips for use with spririt level.



Leveling
Figure 16–39


40'4" (12.0m)
30'11" (9.4m)
52'6" (16.0m)
Approx 47' (14.4m)
78'3" (23.87m)
52'6" (16.0m)
50°
39'10.7" (12.17m) RH Main Wheel Turnig Radius
40'4.7" (12.32m) Nose Wheel Turning Radius
11'8.3" (3.57m) LH Main Wheel Turning Radius

Towing & Taxing
Figure 16–40

Precautions

(1) Before lubricating, clean the parts involved.

(2) When the grease gun is used, fill the bearings with grease until the grease swells out from the bearing surfaces uniformly. Wipe off the grease thus swollen out.

(3) Do not lubricate the rusted surfaces.

(4) Clean the sealed bearings, unsealed bearings etc. because the bearing surfaces are damaged if foreign matters such as sands are contained in them.

For lubricating materials, intervals and procedures, see the following tables:

Symbol	Specification	Nomenclature	Purpose
GLT	MIL-G-23827	Grease, Aircraft & Instrument, Gear & Actuator	For low and high temperatures. Used for ball, roller or needle bearings and sliding and rolling surfaces of precision machinery and flight control system.
GH	MIL-L-3545	Grease High Temperature	For high temperature. Used for landing gear, wheel bearings etc. which run at high speeds and high temperatures.
GB	MIL-L-7711	Grease General Purpose	For general use.
GG	MIL-G-7187	Grease Graphite	Graphite grease. Used for heavily loaded parts or low speed bearing surfaces which can not be lubricated easily or which are operated intermittently.
OGP	MIL-L-7870	Oil, General Purpose Low Temperature	For general use.
OHA	MIL-H-5606	Hydraulic Fluid Petroleum Base	Hydraulic fluid. Used as hydraulic oil in hydraulic system, brakes and shock struts.

Symbol	Specification	Nomenclature	Purpose
FG	MIL-G-6711	Graphite Lubricate	Graphite powder. Used as dry lubricant. It can be substituted by DIXONS STICK NOG-771. Symbol FGS.
Special No.1	ANDOK 260 or MARFAK 3HD	Grease	Special grease. Used for special quills, drive shaft serrations etc.
Special No.2	F96(20) Shin'etsu Chemical	Silicone Oil	

* Interval Symbols

△ .... 1B (150 hours)
○ .... 3B (450 hours)
◇ .... 1C (400 hours)
⬡ .... 2C (800 hours)
□ .... 4C (1600 hours)
◡ .... Special

* Lubricating Method Symbols

.... Grease gun

.... Oiler

.... Hand

.... Brush

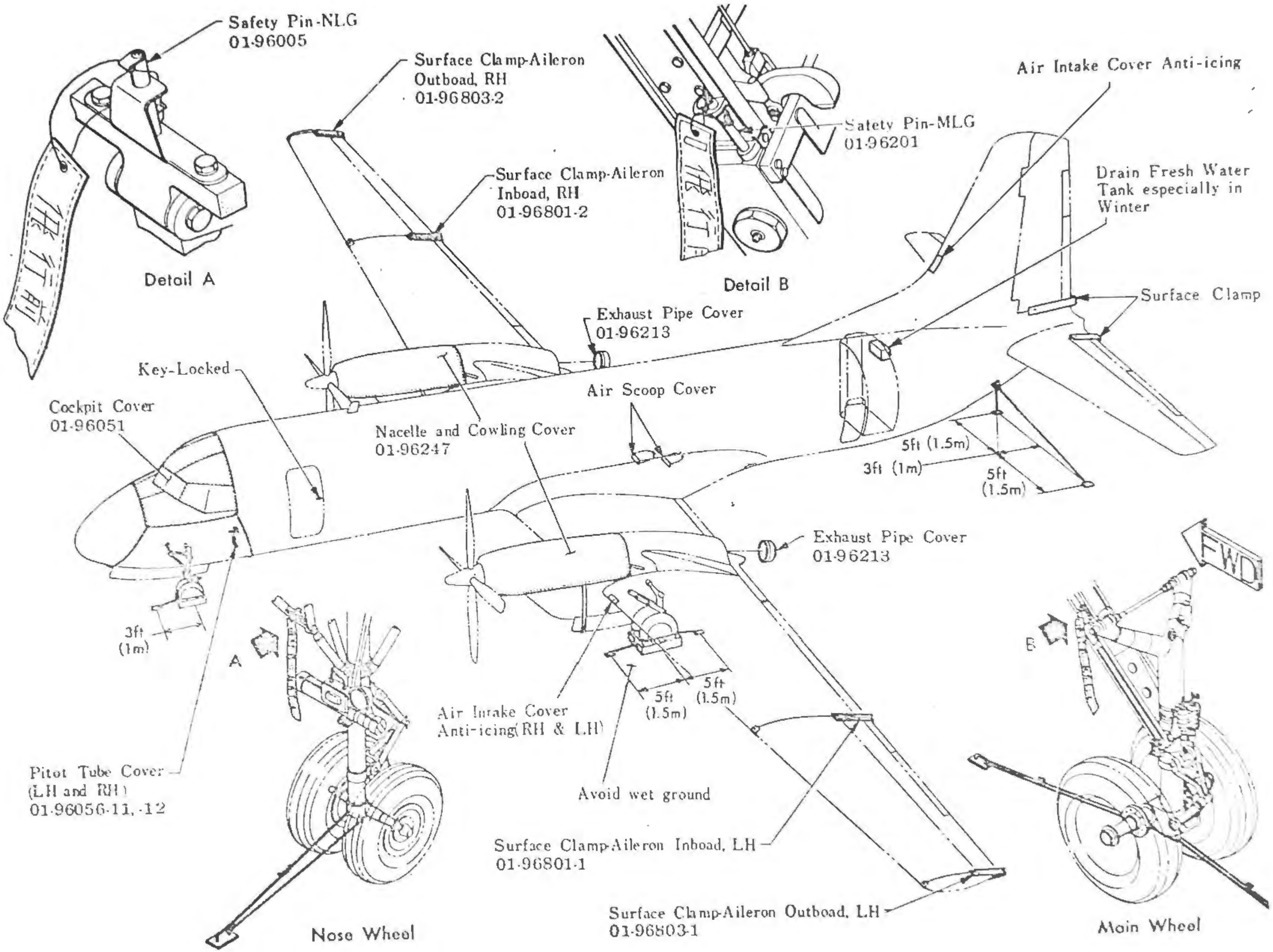
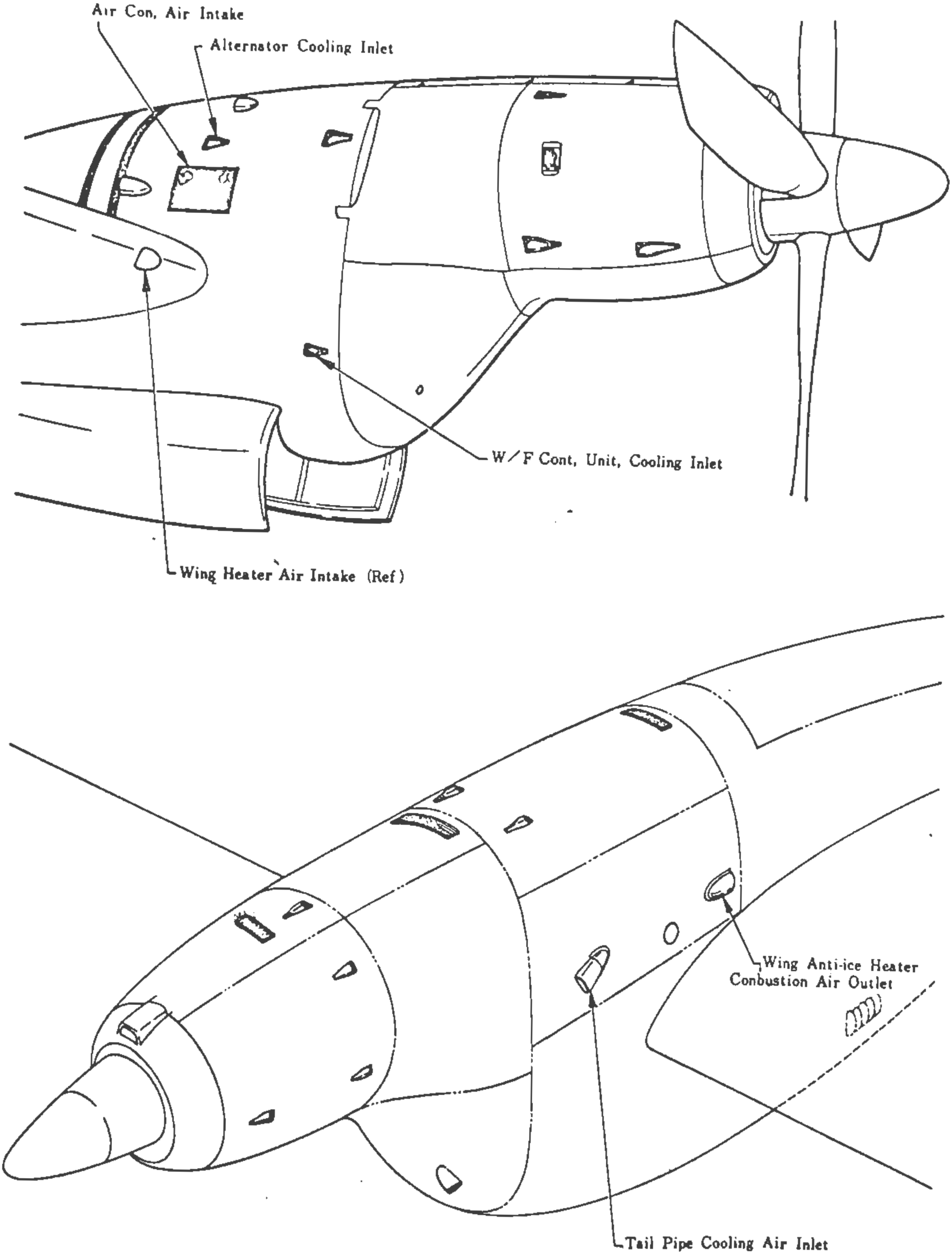


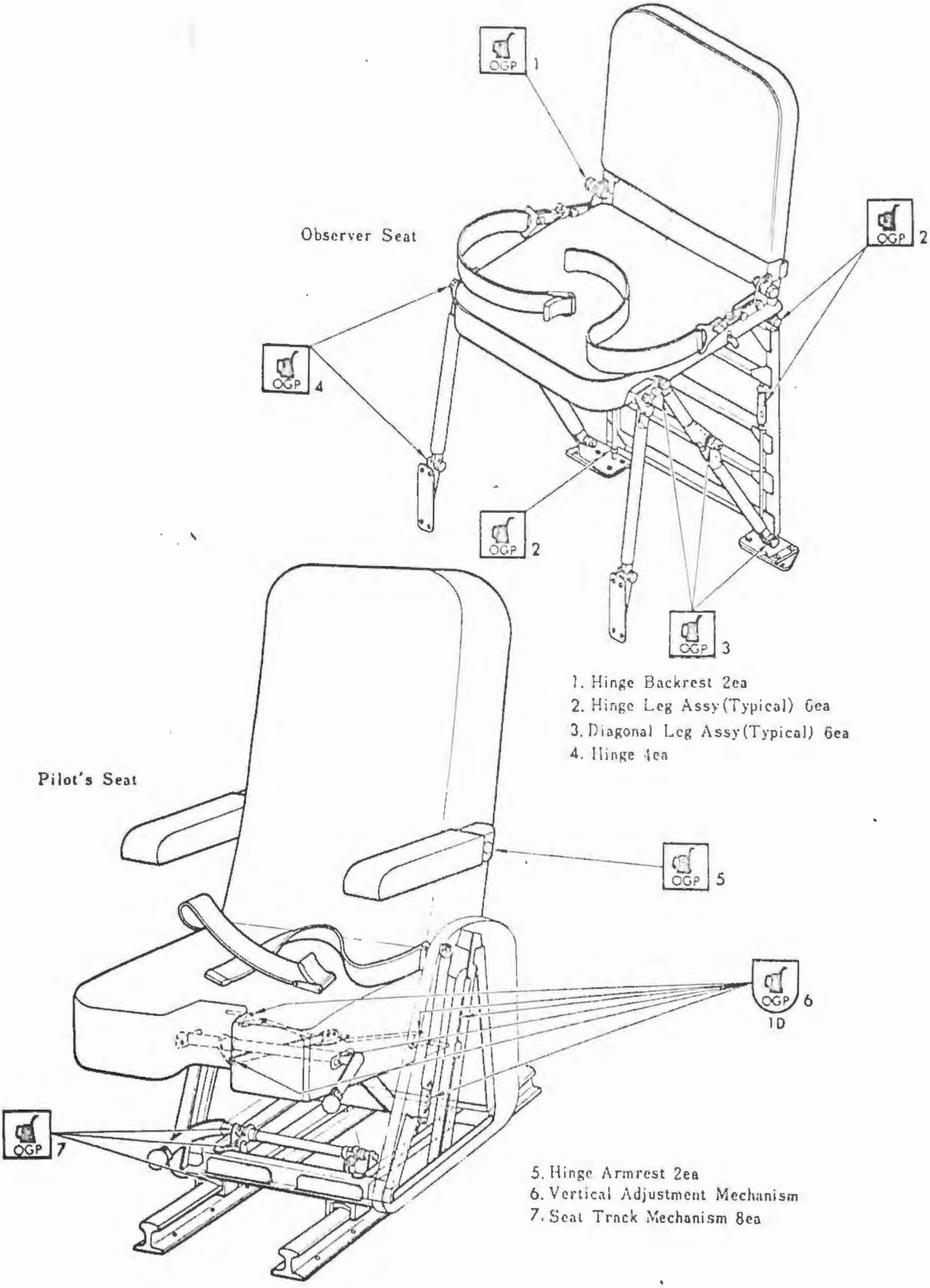
Figure 16-41

Mooring


Air Con, Air Intake
Alternator Cooling Inlet
W/F Cont, Unit, Cooling Inlet
Wing Heater Air Intake (Ref)
Wing Anti-ice Heater Conbustion Air Outlet
Tail Pipe Cooling Air Inlet

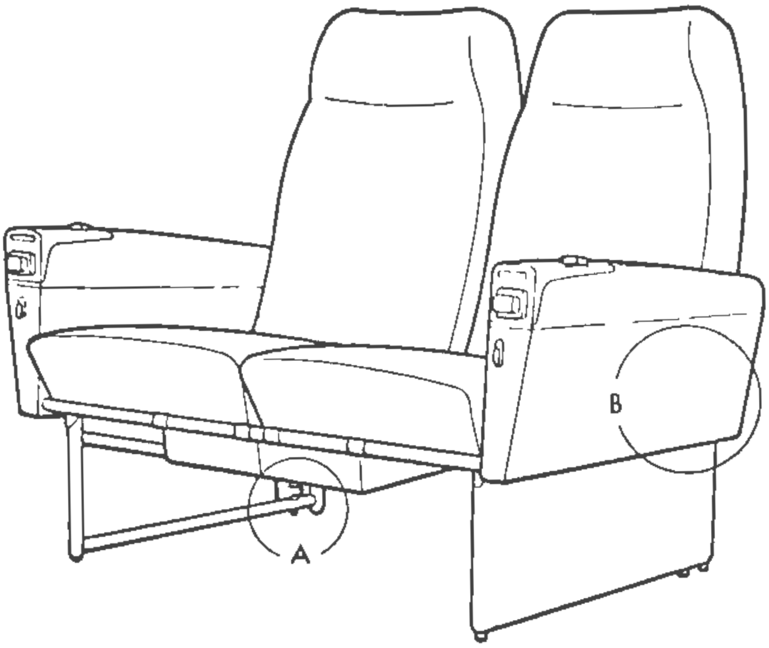
Cleaning Reference Port (2/2)

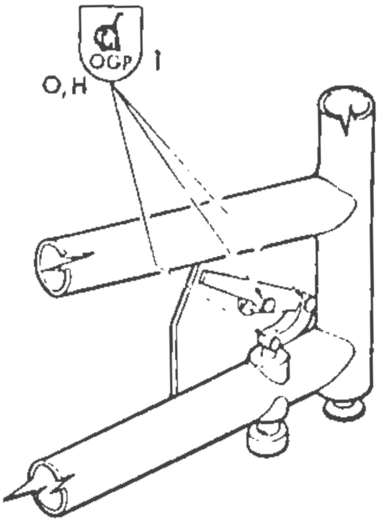
Figure 16-42


Observer Seat
OGP 1
OGP 2
OGP 4
OGP 2
OGP 3
1. Hinge Backrest 2ea
2. Hinge Leg Assy(Typical) 6ea
3. Diagonal Leg Assy(Typical) 6ea
4. Hinge 4ea
Pilot's Seat
OGP 5
OGP 6
1D
OGP 7
5. Hinge Armrest 2ea
6. Vertical Adjustment Mechanism
7. Seat Track Mechanism 8ea

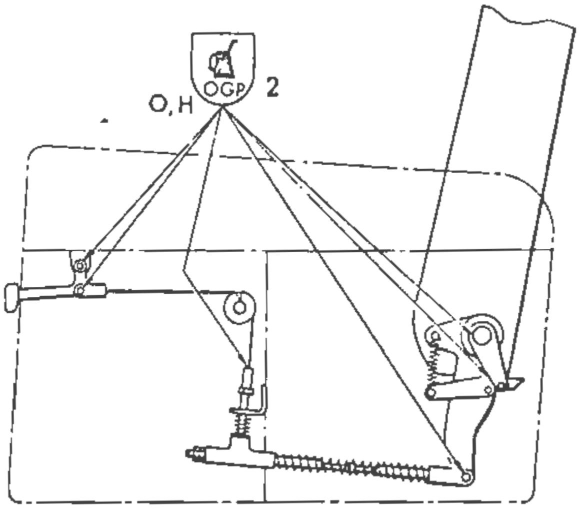
Lubrication-Pilot's Seat and Observer Seat

Figure 16-43





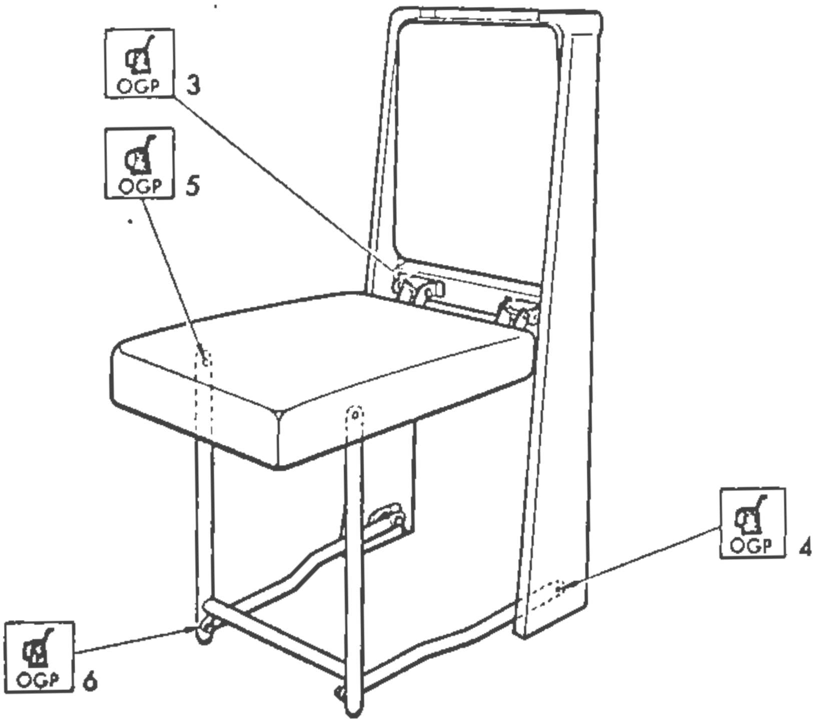
Detail A



Detail B

Passenger Seat

1, Seat Attachment (Typical) 2ea
2, Recline Mechanism (Typical) 2ea

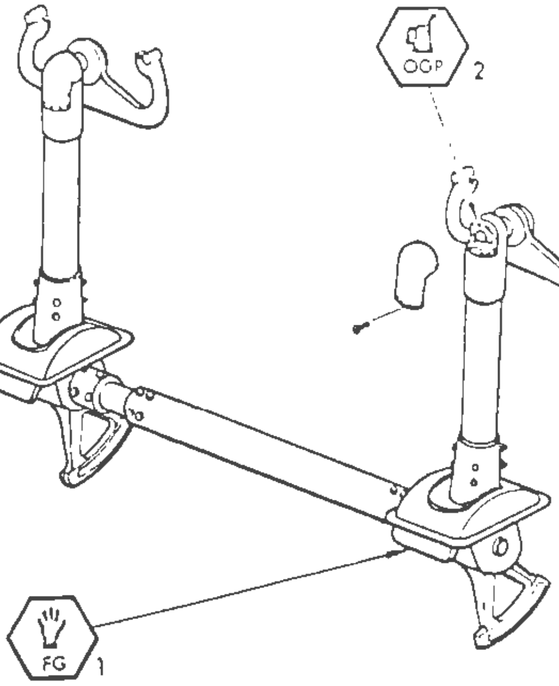


Stewardess Seat

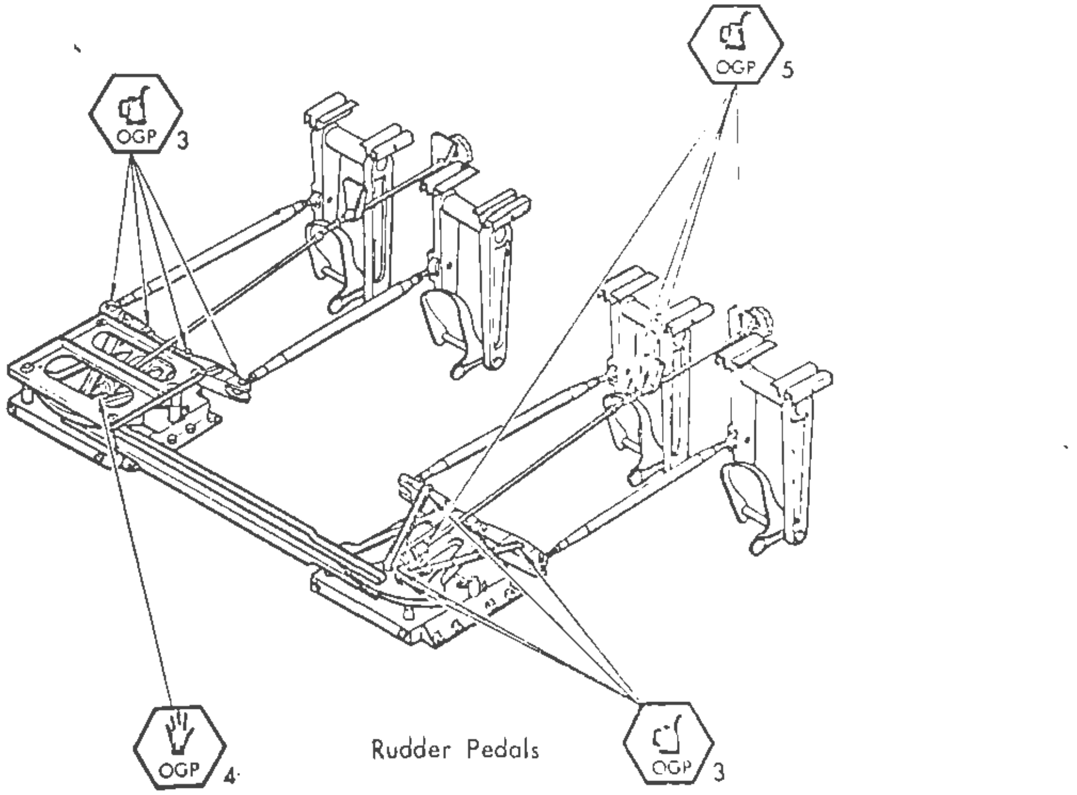
3, Hinge Backrest 2ea
4, Hinge Leg 2ea
5, Hinge Leg 2ea
6, Hinge Leg 2ea

Lubrication—Passenger and Stewardess Seat

Figure 16-44



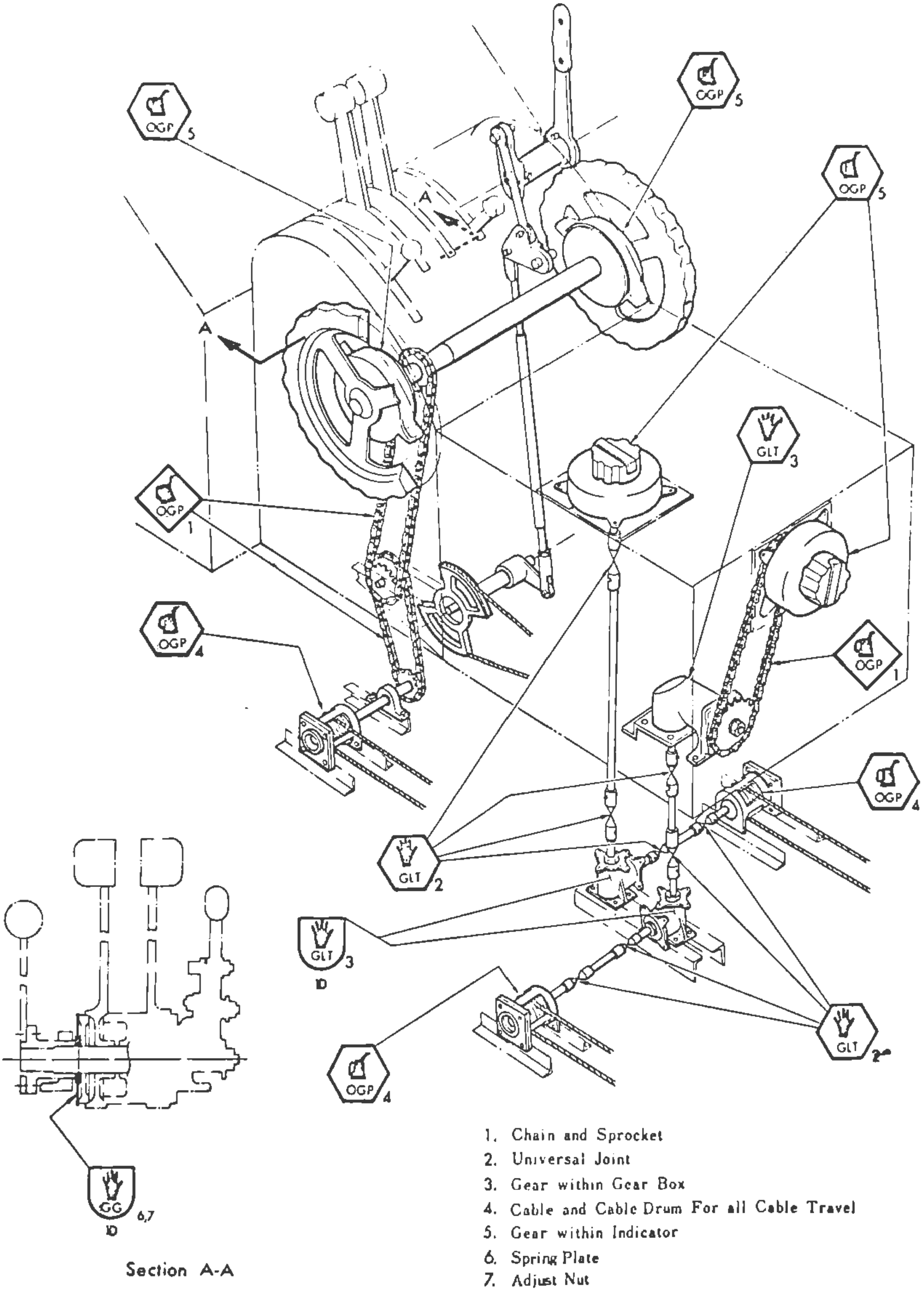
Control Columms



Rudder Pedals

1. Fairing Slide at the Control Column 2ea
2. Control Cable and Drum for all Cable Travel 2ea
3. Rudder Quadrant Linkage 2ea
4. Rudder Quadrant Adjast Screw 2ea
   Pedal; Longitudinal Axis Adjust Mechanism 2ea

Lubrication-Control Columns and Rudder Pedals
Figure 16-45

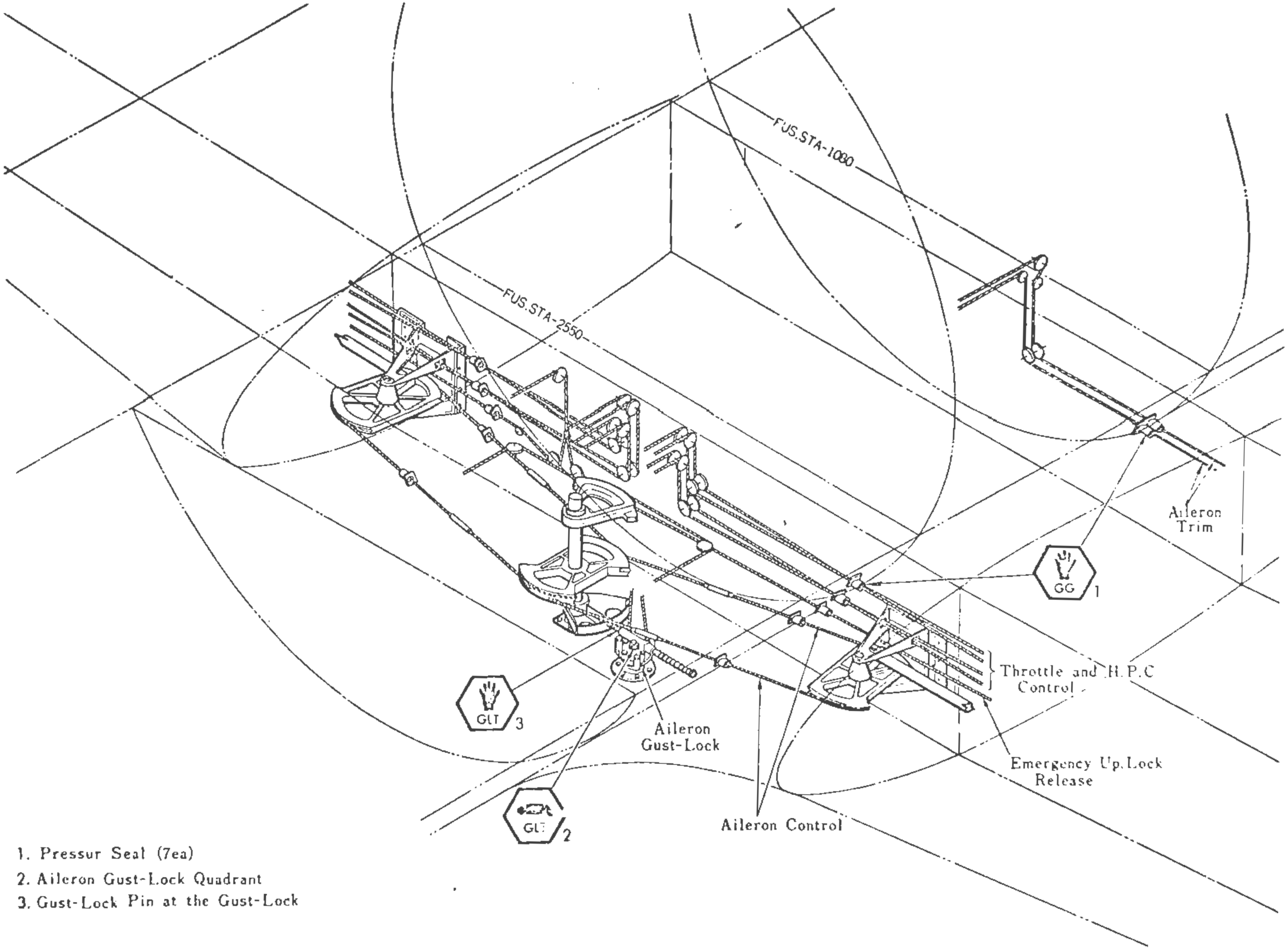


Section A-A

1. Chain and Sprocket
2. Universal Joint
3. Gear within Gear Box
4. Cable and Cable Drum For all Cable Travel
5. Gear within Indicator
6. Spring Plate
7. Adjust Nut

Lubvication-Control System-Pedestal Section

Figure 16-46

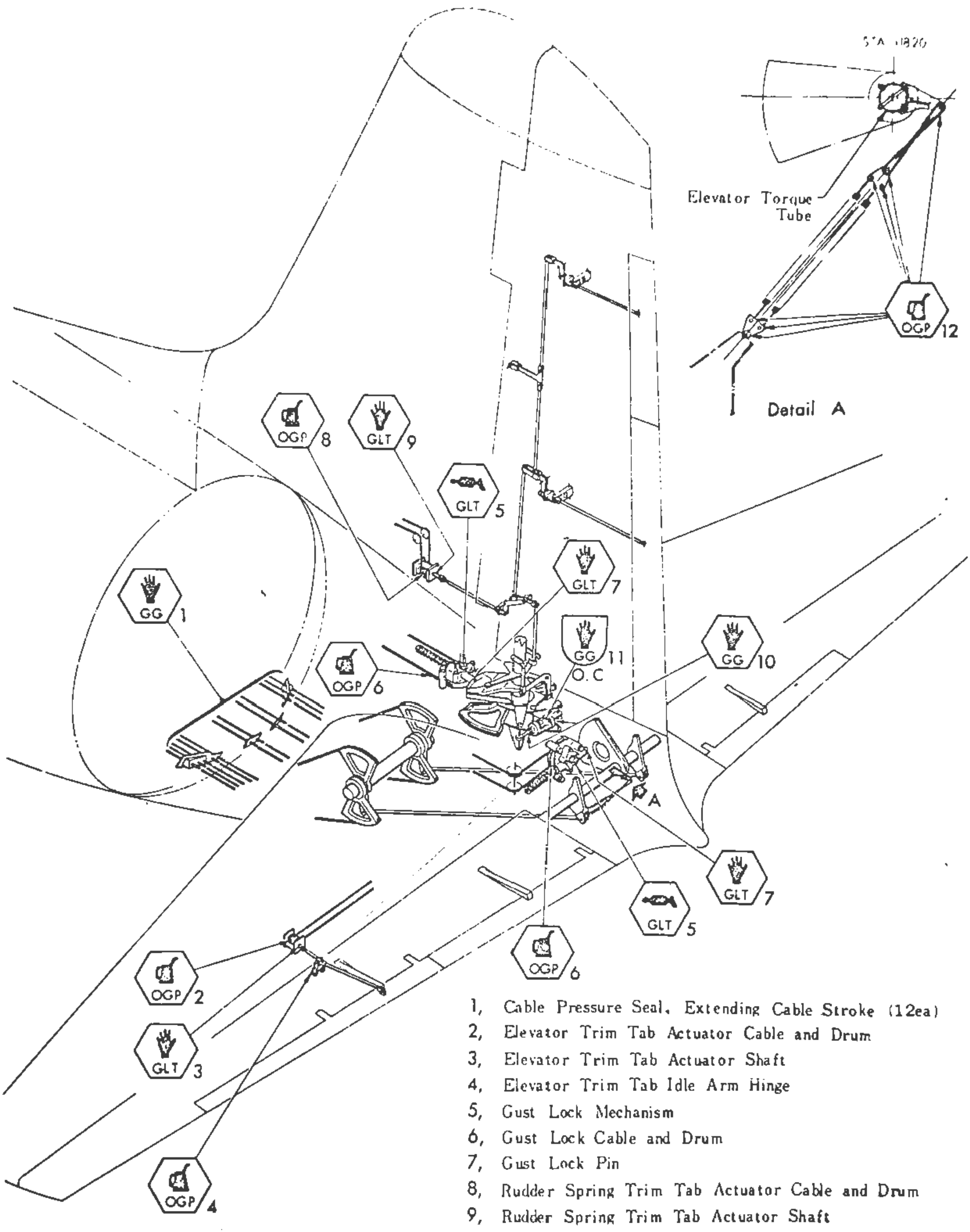


1. Pressur Seal (7ea)
2. Aileron Gust-Lock Quadrant
3. Gust-Lock Pin at the Gust-Lock

Lubrication-Control System-Wing and Middle Fuselage
Figure 16–47

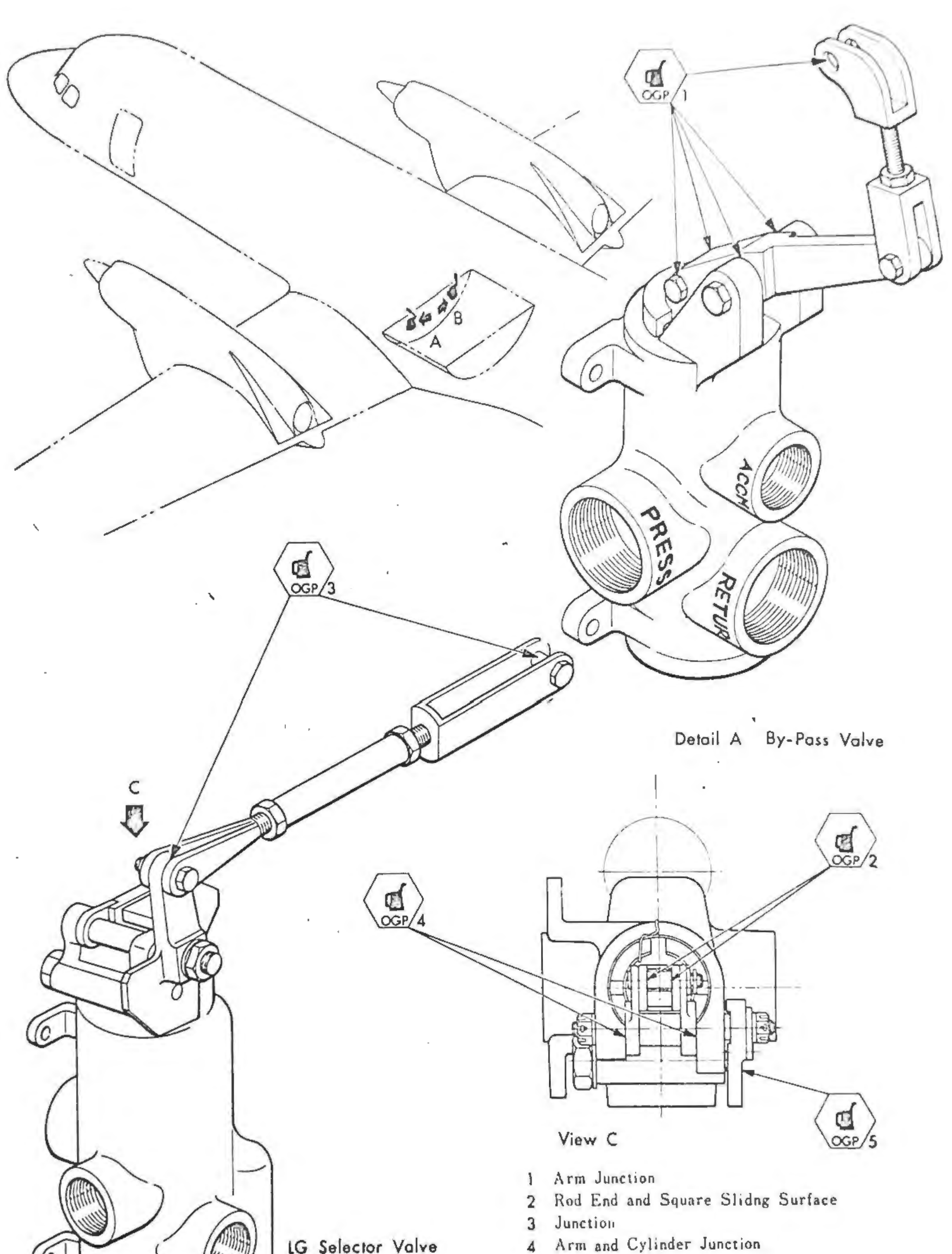
DELETED

Figure 16-48



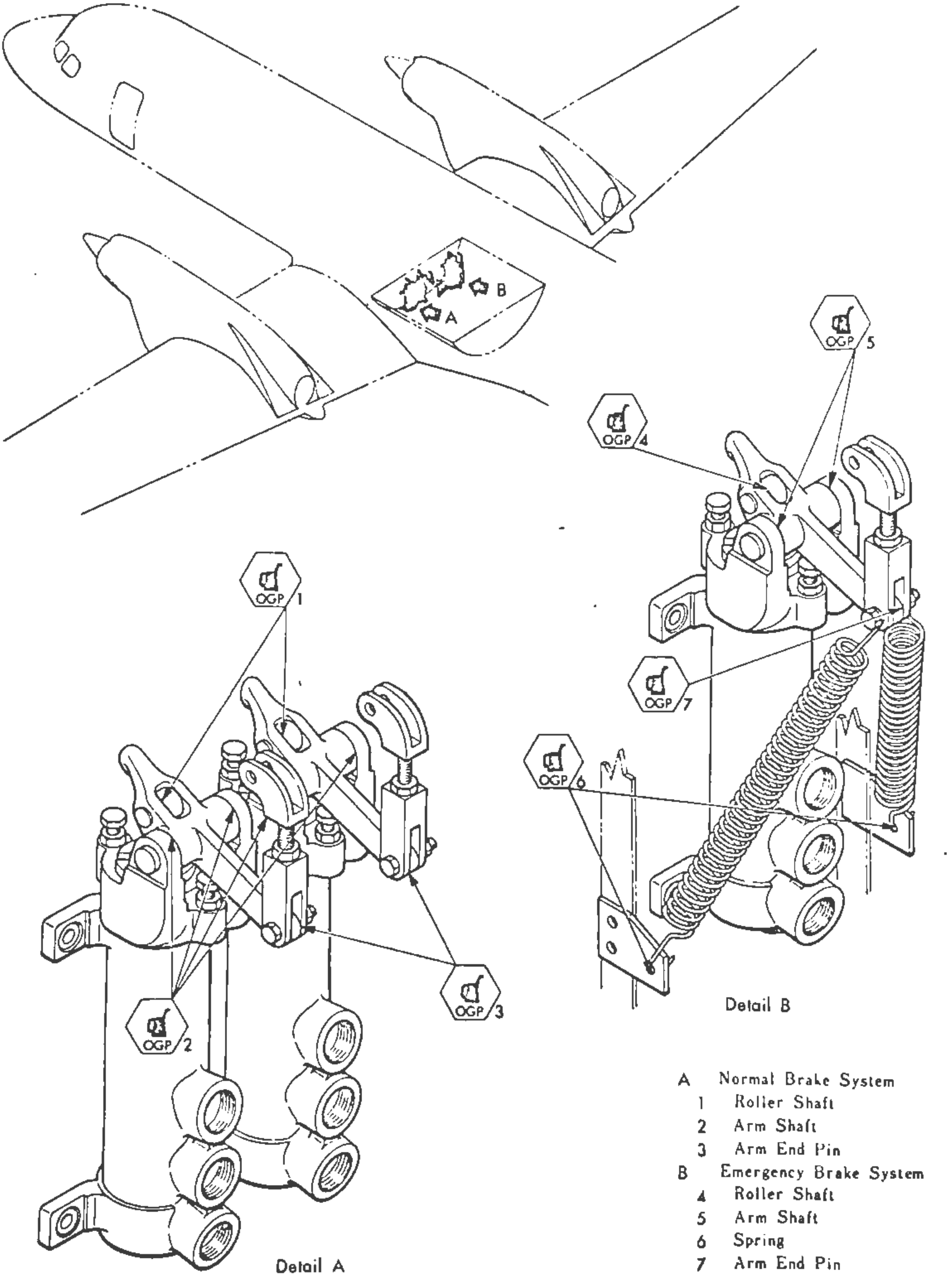
1, Cable Pressure Seal, Extending Cable Stroke (12ea)
2, Elevator Trim Tab Actuator Cable and Drum
3, Elevator Trim Tab Actuator Shaft
4, Elevator Trim Tab Idle Arm Hinge
5, Gust Lock Mechanism
6, Gust Lock Cable and Drum
7, Gust Lock Pin
8, Rudder Spring Trim Tab Actuator Cable and Drum
9, Rudder Spring Trim Tab Actuator Shaft
10, Rod (Sliding Surface)
11, Spring (Rudder Spring Tab Mechanism)
12, Down Spring Mechanism (7ea)

Control System-Empennage Section
Figure 16–50



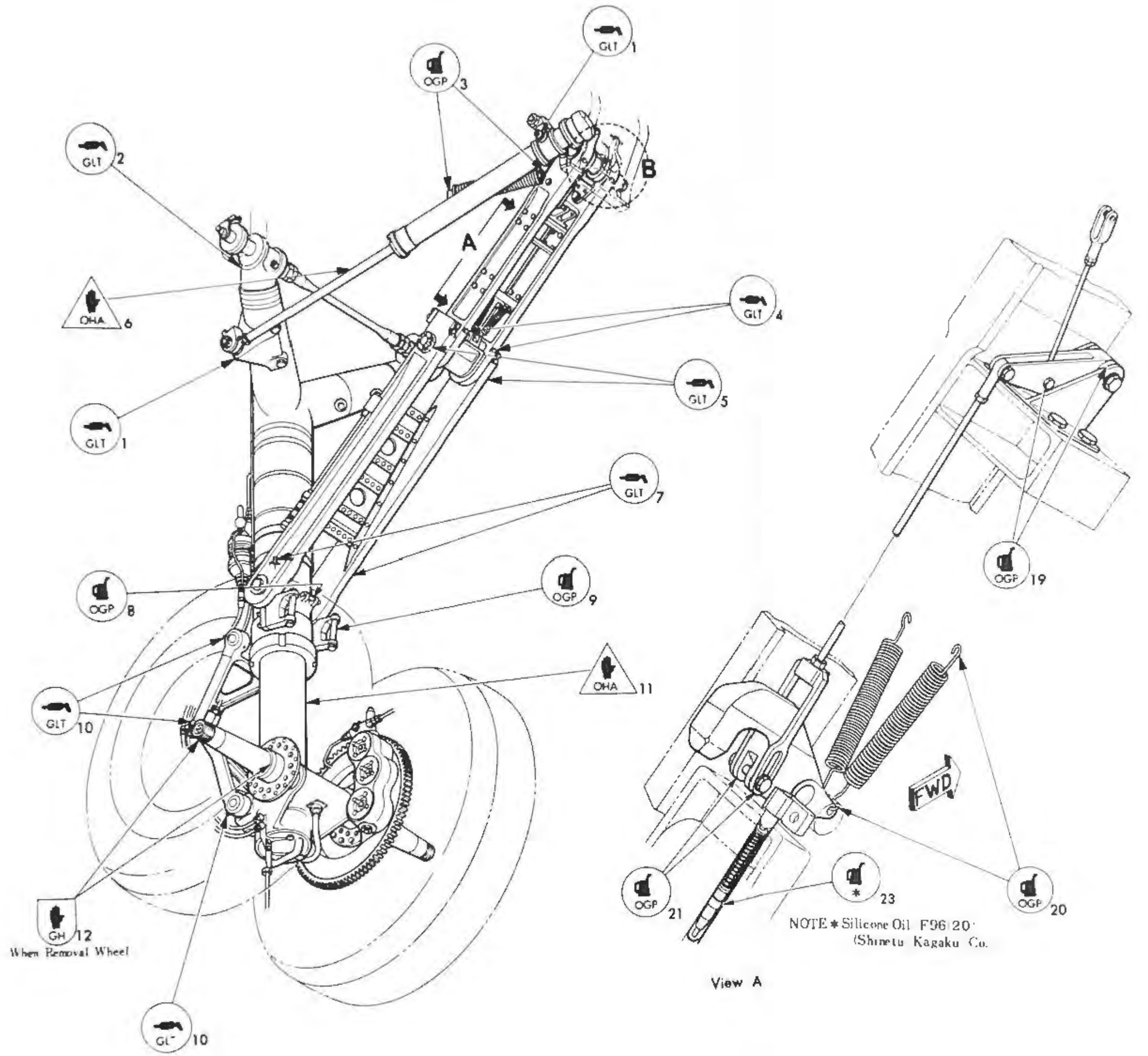
1 Arm Junction
2 Rod End and Square Slidng Surface
3 Junction
4 Arm and Cylinder Junction
5 Stopper and Crank Junction

Lubrication-Hydraulic System
Figure 16–51



A Normal Brake System
 1 Roller Shaft
 2 Arm Shaft
 3 Arm End Pin
B Emergency Brake System
 4 Roller Shaft
 5 Arm Shaft
 6 Spring
 7 Arm End Pin

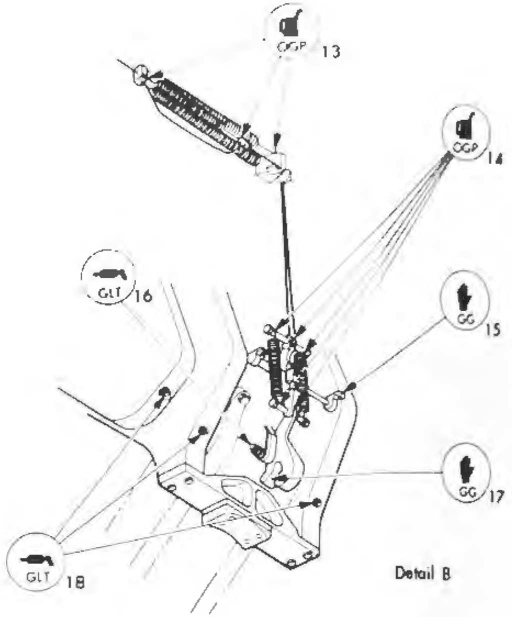
Lubrication-Brake System
Figure 16–52



When Removal Wheel

NOTE * Silicone Oil F96(20)
(Shinetu Kagaku Co.

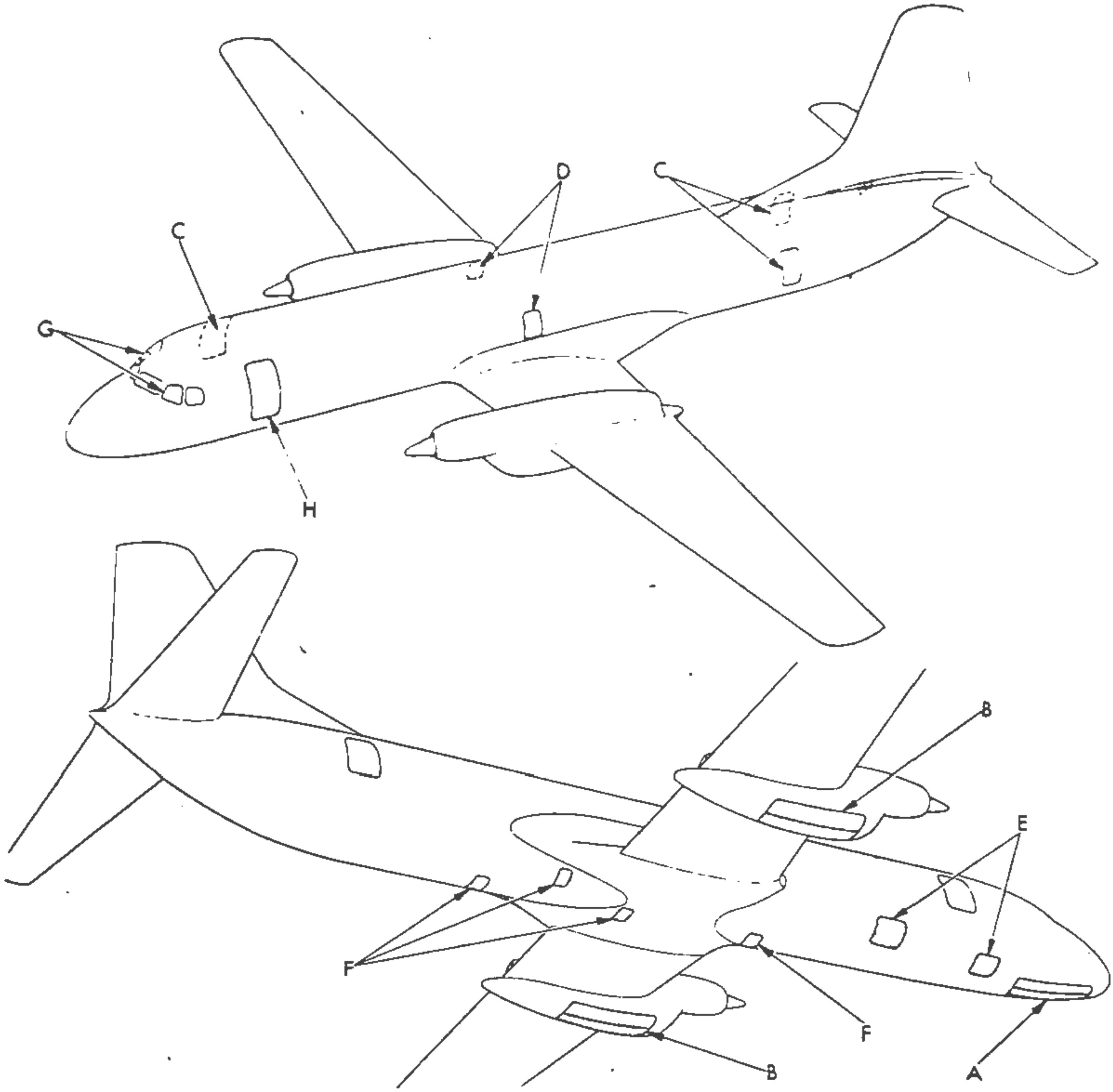
View A



Detail B

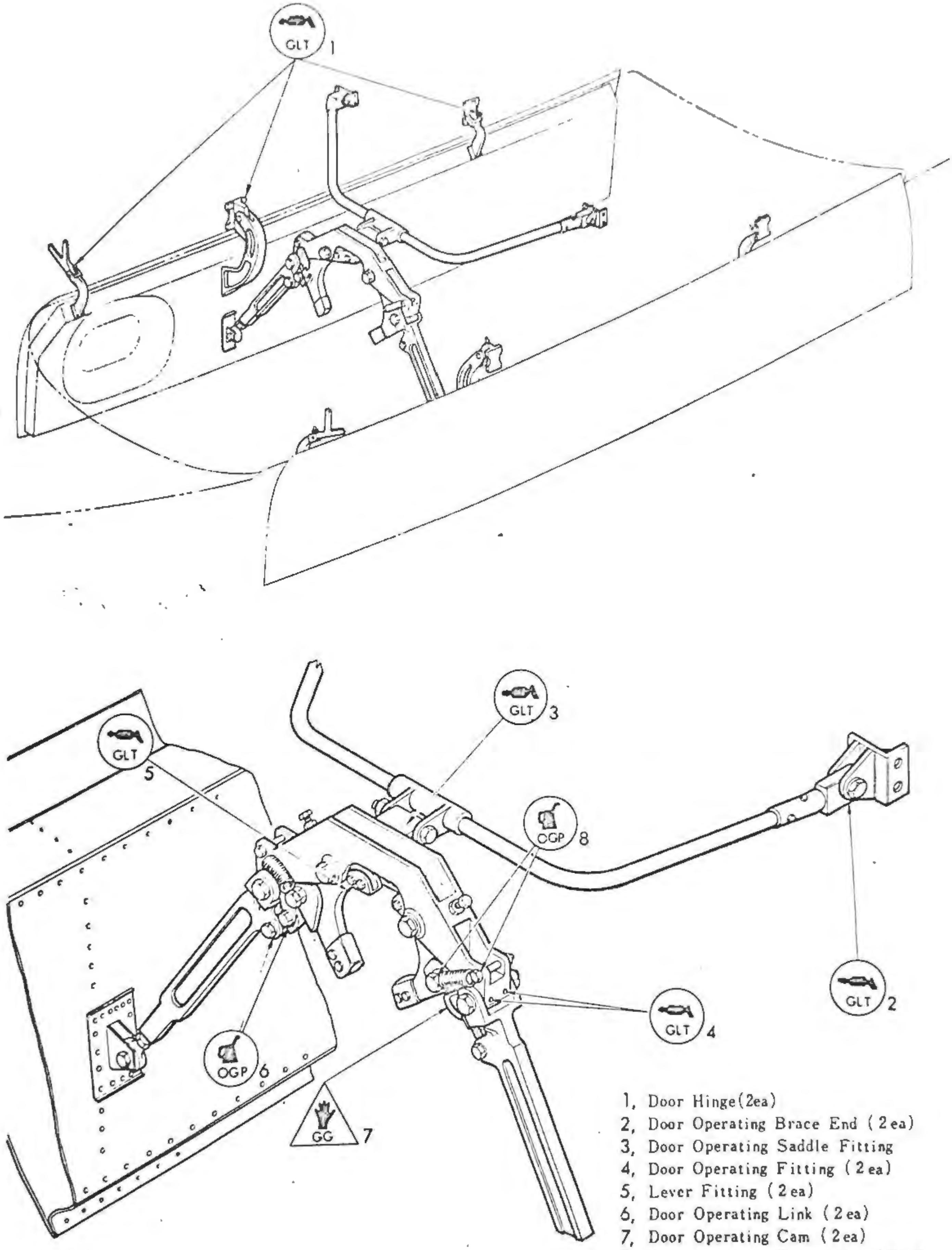
1 Actuating Cylinder Fitting
2 Shock Strut Attaching Fitting 2ea
3 Assist Spring End
4 Shaft Down Lock Hook
5 Special Bolt-Upper and Lower Drag Strut
6 Actuating Cylinder Piston Rod
7 Lower Drag Link
8 Roller-Up Lock
9 Roller-MLG Door 2ea
10 Torque Link 2ea
11 Shock Strut Piston
12 Wheel Bearing and Axle 2ea
13 Spring-Emergency Gear Down
14 Up Lock Linkage and Spring End
15 Up Lock Release Lever 2ea
16 Shaft-Up Lock Hook
17 Up Lock Hook
18 Upper Drag Link Attach Fitting
19 Down Lock Linkage 2ea
20 Spring-Emergency Gear Down 2ea
21 Push-pull Rod-Down Lock Hook
22 Deleted
23 Rod Down Lock Indicating Mechanism

Lubrication-Main Landing Gear
Figure 16-53



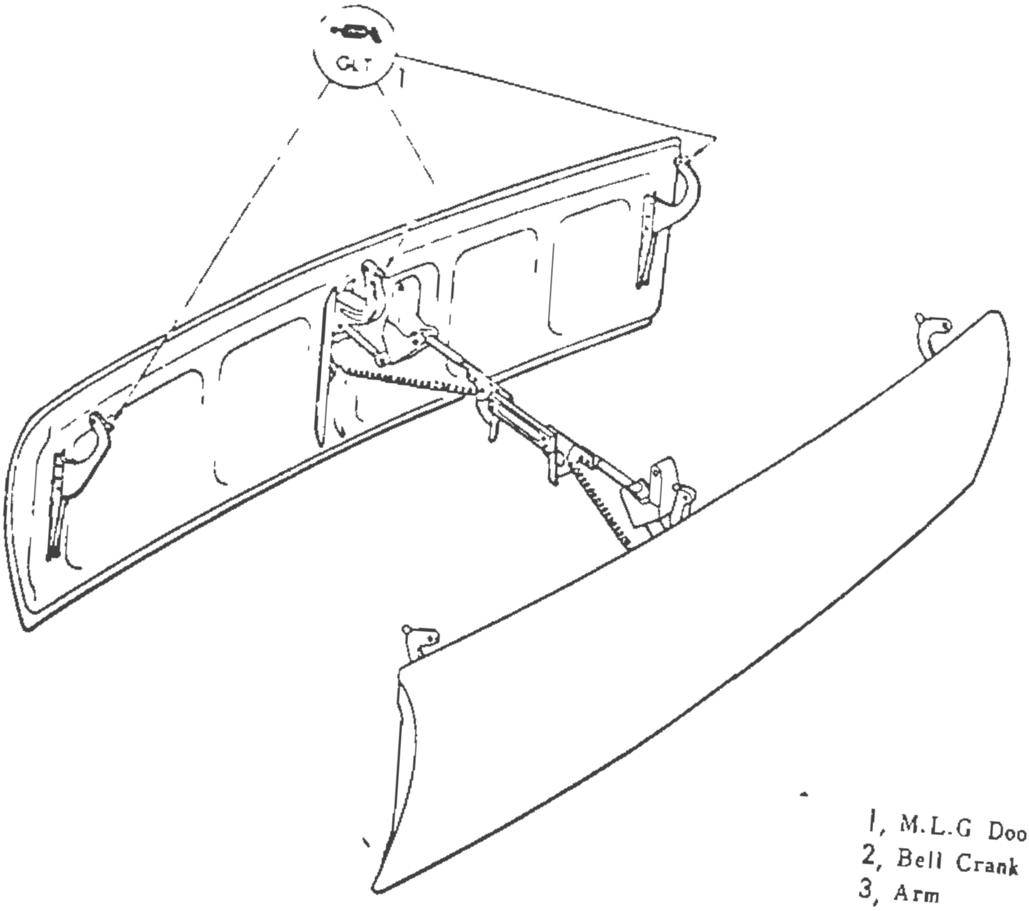
A	Nose Landing Gear Door Mechanism (See 12-20 - 0 Figure 214)
B	Main Landing Gear Door Mechanism (See 12-20-0 Figure 215)
C	Galley Service Door, Front Cargo Door and After Cargo Door (See 12-20-0 Figure 216)
D	Emergency Exit Door (See 12-20-0 Figure 217)
E	Belly Cargo Door and Electrical Access Door (See 12-20-0 Figure 218)
F	Hydraulic, Air-cond. and Flight Control Access Door (See 12-20-0 Figure 219)
G	Sliding Windshield (See 12-20-0 Figure 220)
H	Cabin Entrance Door (See 12-20-0 Figure 221)

Lubrication-Fuselage Section
Figure 16-56

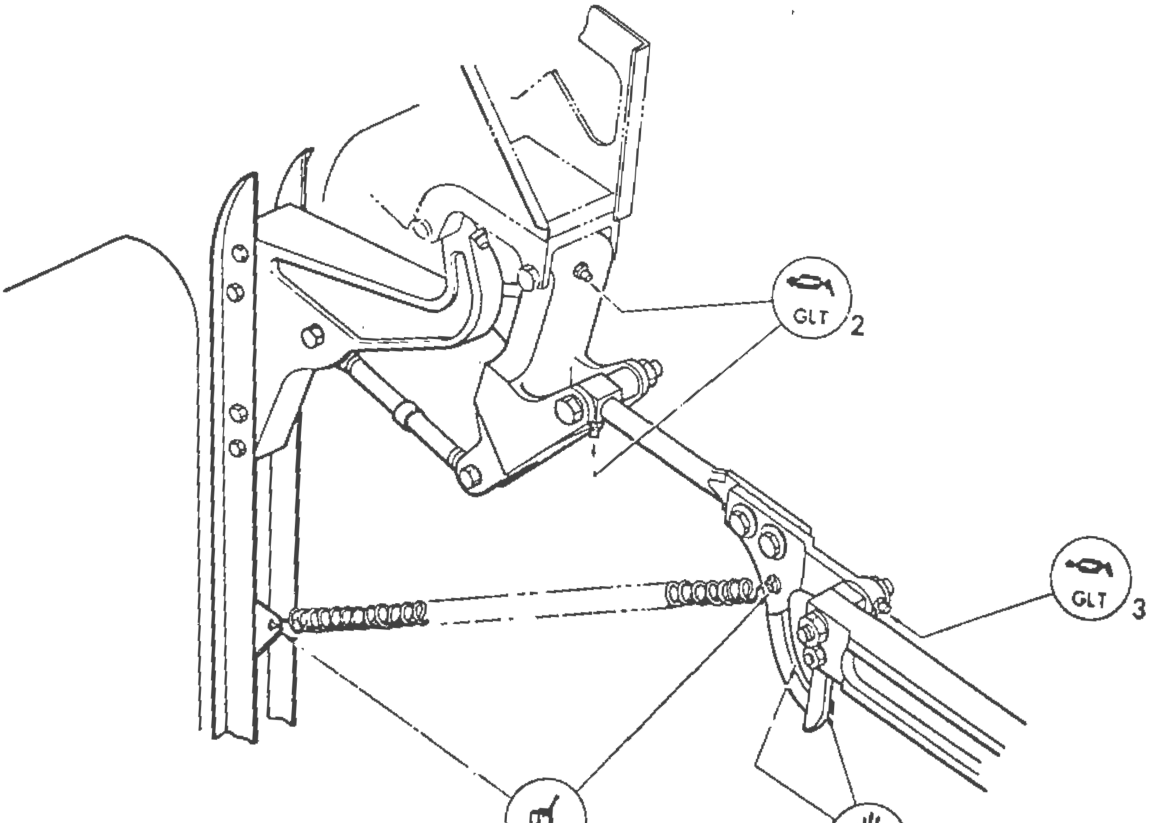


1, Door Hinge(2ea)
2, Door Operating Brace End (2ea)
3, Door Operating Saddle Fitting
4, Door Operating Fitting (2ea)
5, Lever Fitting (2ea)
6, Door Operating Link (2ea)
7, Door Operating Cam (2ea)
8, Door Operating Spring End (2ea)

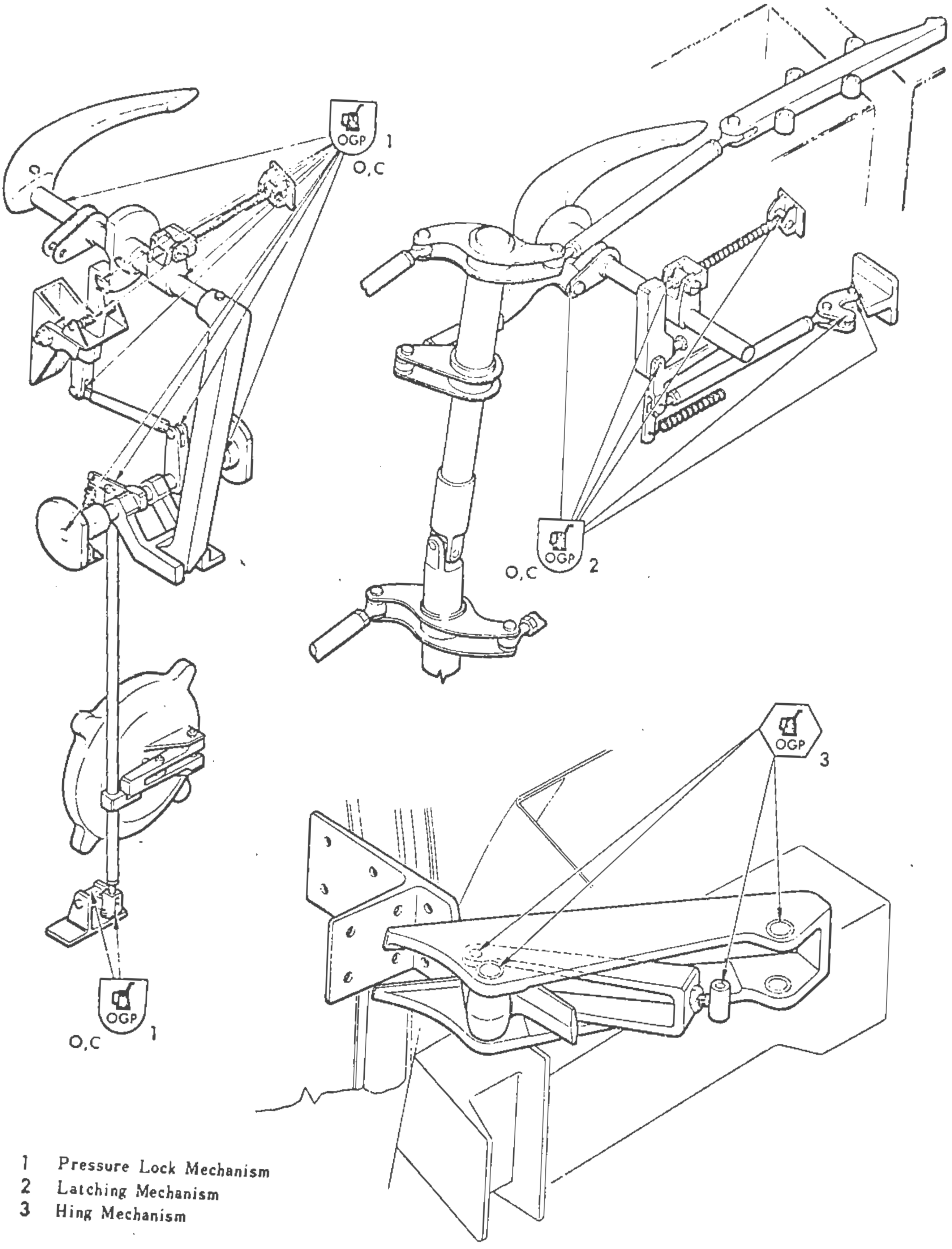
Lubrication—Nose Landing Gear Door Mechanism
Figure 16–57



1, M.L.G Door Hinge	(2 ea)
2, Bell Crank Hinge	(2 ea)
3, Arm	(2 ea)
4, Hook and Guide	(2 ea)
5, Spring	(2 ea)

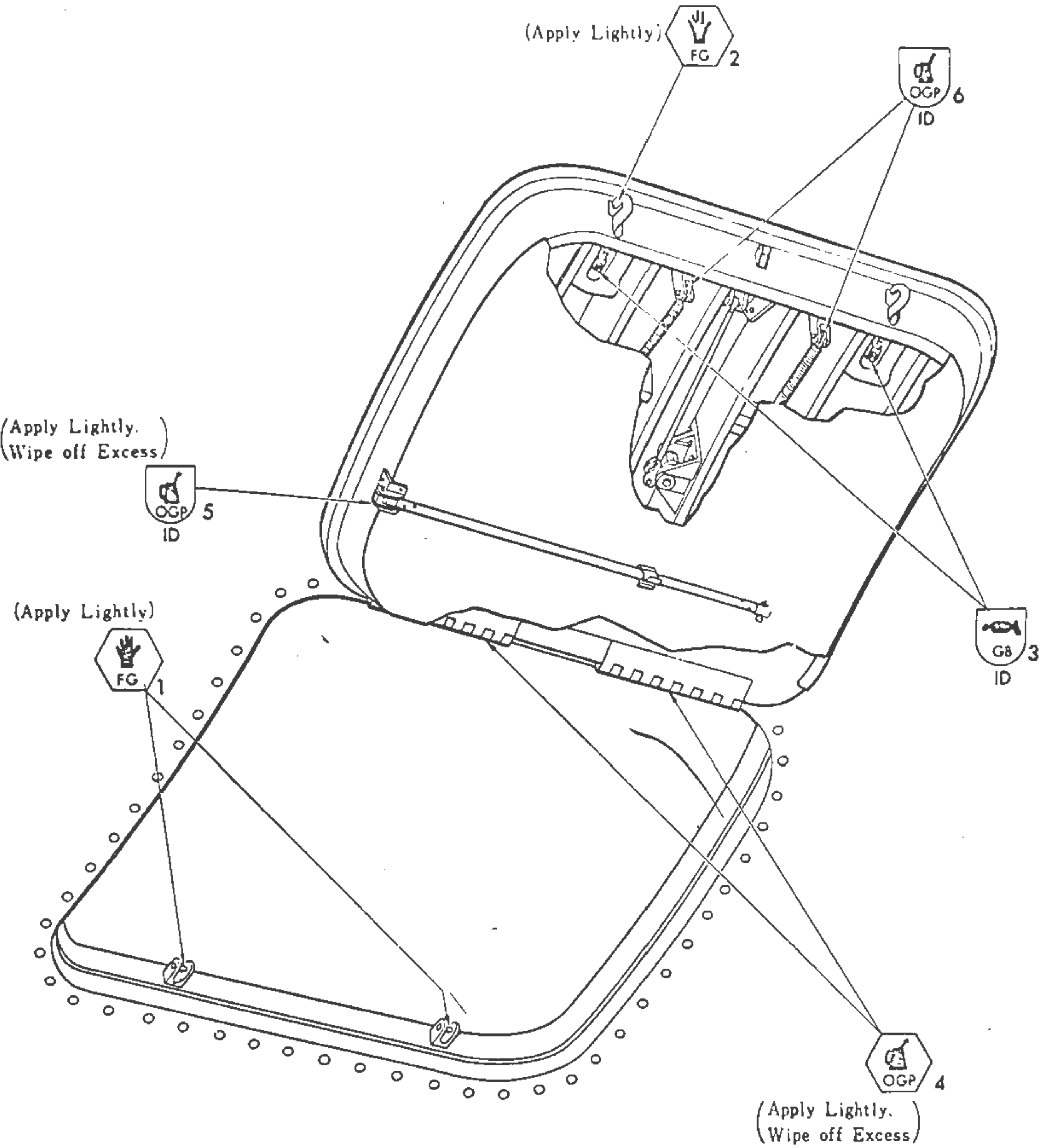


Lubrication Main Landing Gear Door Mechanism
Figure 16–58



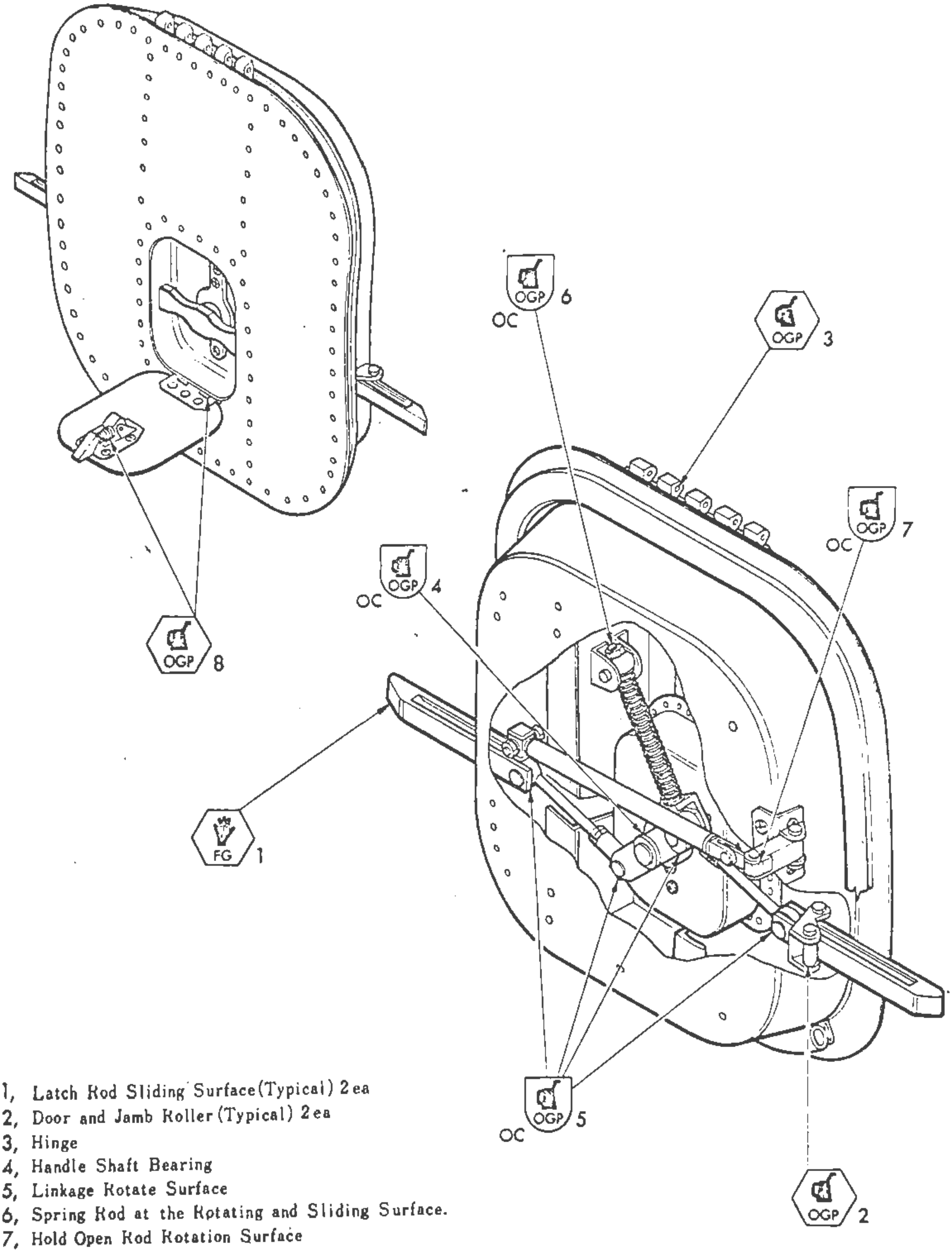
Lubrication—Galley Service Door,
Front Cargo Door, After Cargo Door

Figure 16–60


(Apply Lightly)
FG 2
OGP 6
ID
(Apply Lightly. Wipe off Excess)
OGP 5
ID
(Apply Lightly)
FG 1
GB 3
ID
OGP 4
(Apply Lightly. Wipe off Excess)

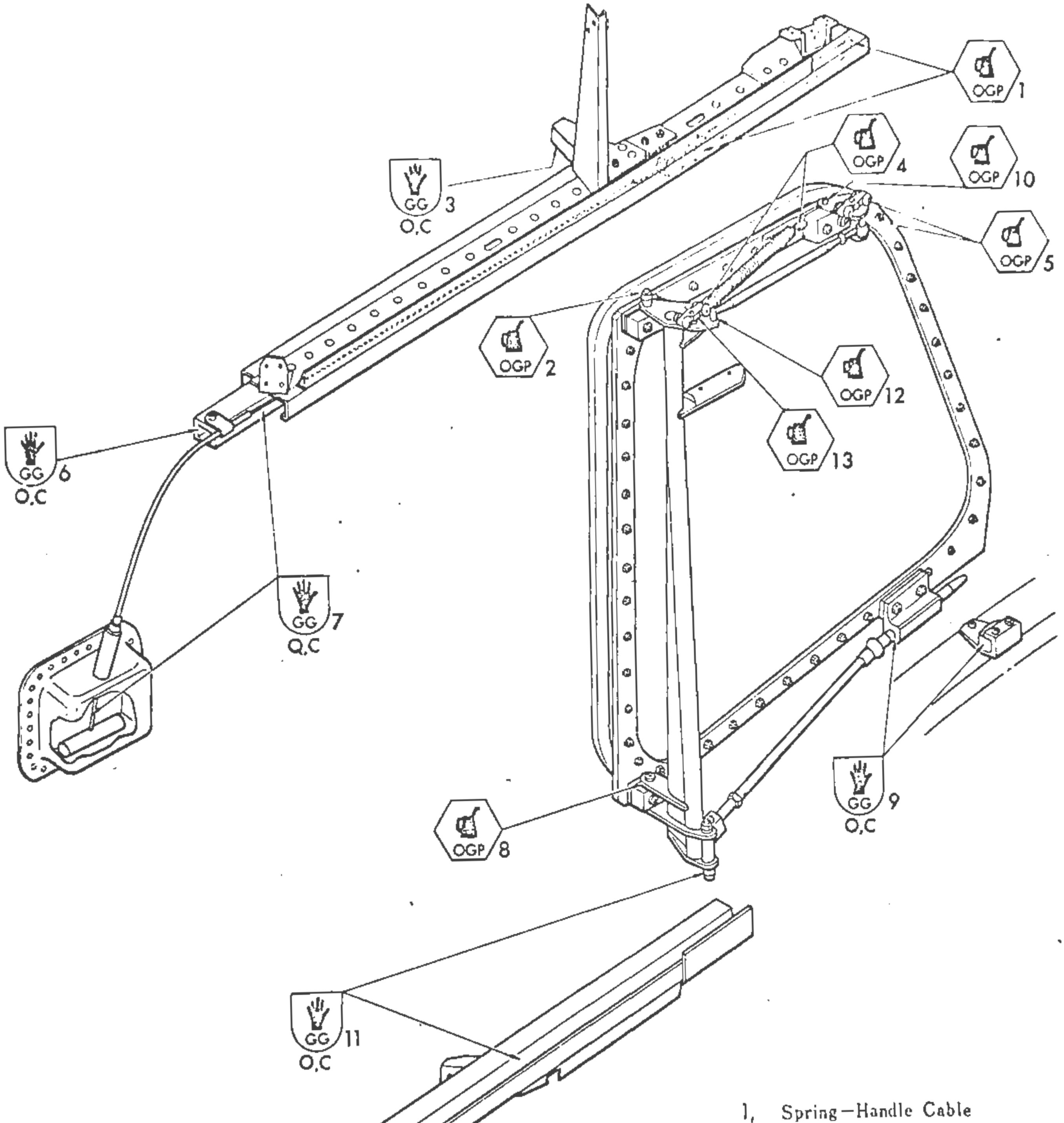
1, Latch Yoke Sliding Surface
2, Latch Hook Sliding Surface 2ea
3, Grease Fitting at the Latch Hook
4, Hinge
5, Hole Open Rod Sliding Surface
6, Rod End

Lubrication — Belly Cargo and Electrical Access Door
Figure 16–62



1, Latch Rod Sliding Surface (Typical) 2 ea
2, Door and Jamb Roller (Typical) 2 ea
3, Hinge
4, Handle Shaft Bearing
5, Linkage Rotate Surface
6, Spring Rod at the Rotating and Sliding Surface.
7, Hold Open Rod Rotation Surface
8, Hinge and Latch

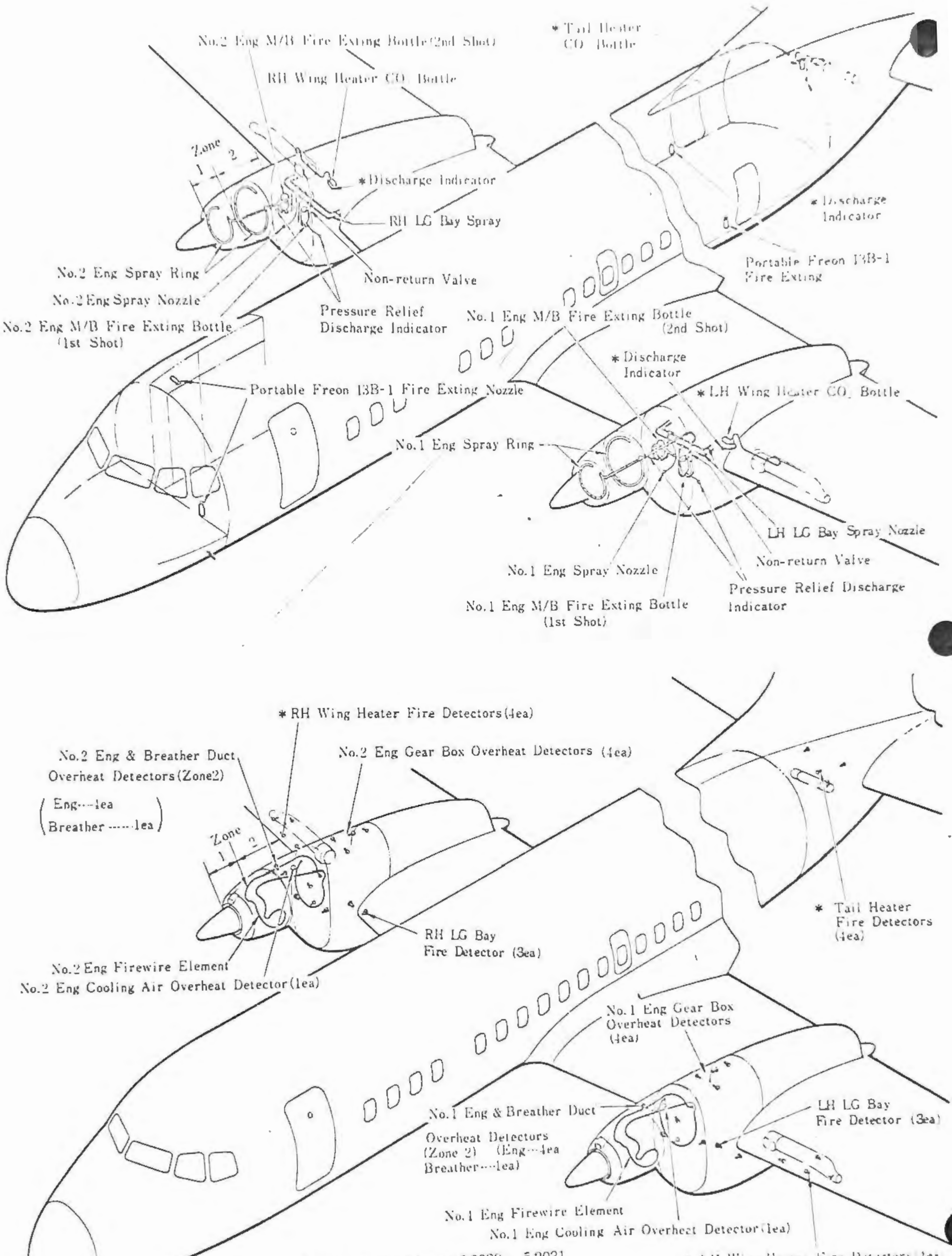
Lubrication – Hydraulic, Air Conditioning
and Flight Control Access Door
Figure 16–63



1, Spring—Handle Cable
2, Bellcrank Roller Hinge 4 ea
3, Bellcrank Guide
4, Bellcrank Spring
5, Roller—Upper Track 4 ea
6, Upper Track Sliding Surface
7, Handle Cable
8, Bellcrank Hinge—Lower
9, Latch and Guide
10, Bellcrank Hinge—Upper
11, Lower Track Sliding Surface
12, Roller Hinge
13, Roller Fitting Shaft 2 ea

Lubrication—Sliding Windshield

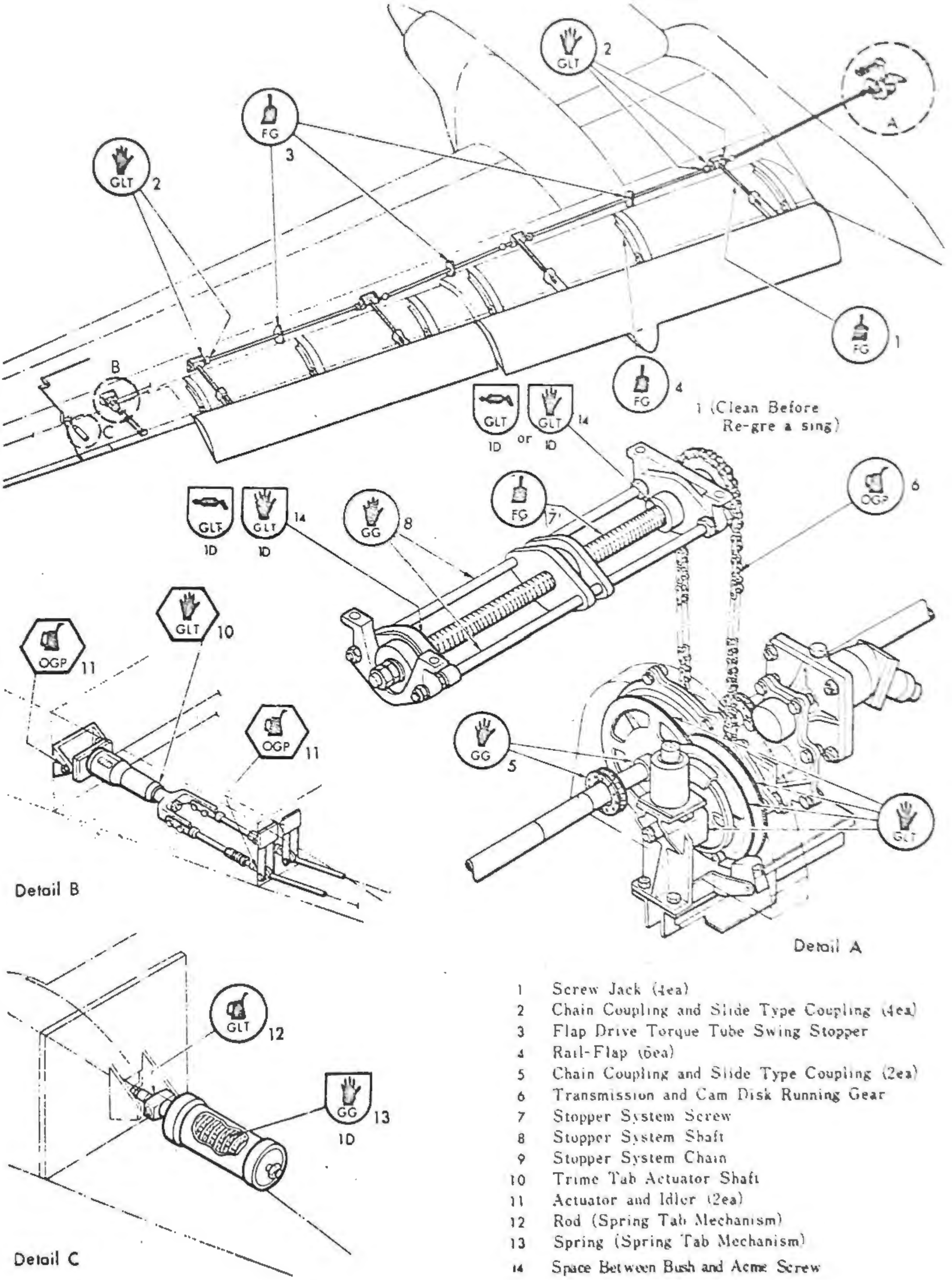
Figure 16—64


No.2 Eng M/B Fire Exting Bottle(2nd Shot)
* Tail Heater CO2 Bottle
RH Wing Heater CO2 Bottle
Zone 1 2
*Discharge Indicator
RH LG Bay Spray
* Discharge Indicator
Portable Freon 13B-1 Fire Exting
No.2 Eng Spray Ring
Non-return Valve
No.2 Eng Spray Nozzle
Pressure Relief Discharge Indicator
No.2 Eng M/B Fire Exting Bottle (1st Shot)
No.1 Eng M/B Fire Exting Bottle (2nd Shot)
* Discharge Indicator
Portable Freon 13B-1 Fire Exting Nozzle
* LH Wing Heater CO2 Bottle
No.1 Eng Spray Ring
LH LG Bay Spray Nozzle
Non-return Valve
No.1 Eng Spray Nozzle
Pressure Relief Discharge Indicator
No.1 Eng M/B Fire Exting Bottle (1st Shot)
* RH Wing Heater Fire Detectors(4ea)
No.2 Eng & Breather Duct Overheat Detectors(Zone2)
(Eng---4ea Breather------1ea)
No.2 Eng Gear Box Overheat Detectors (4ea)
Zone 1 2
RH LG Bay Fire Detector (3ea)
* Tail Heater Fire Detectors (4ea)
No.2 Eng Firewire Element
No.2 Eng Cooling Air Overheat Detector(1ea)
No.1 Eng Gear Box Overheat Detectors (4ea)
No.1 Eng & Breather Duct Overheat Detectors (Zone 2) (Eng---4ea Breather---1ea)
LH LG Bay Fire Detector (3ea)
No.1 Eng Firewire Element
No.1 Eng Cooling Air Overheat Detector(1ea)
* LH Wing Heater Fire Detectors(4ea)

* not applicable to #2029~ #2031

Fire Protection System Arrangement

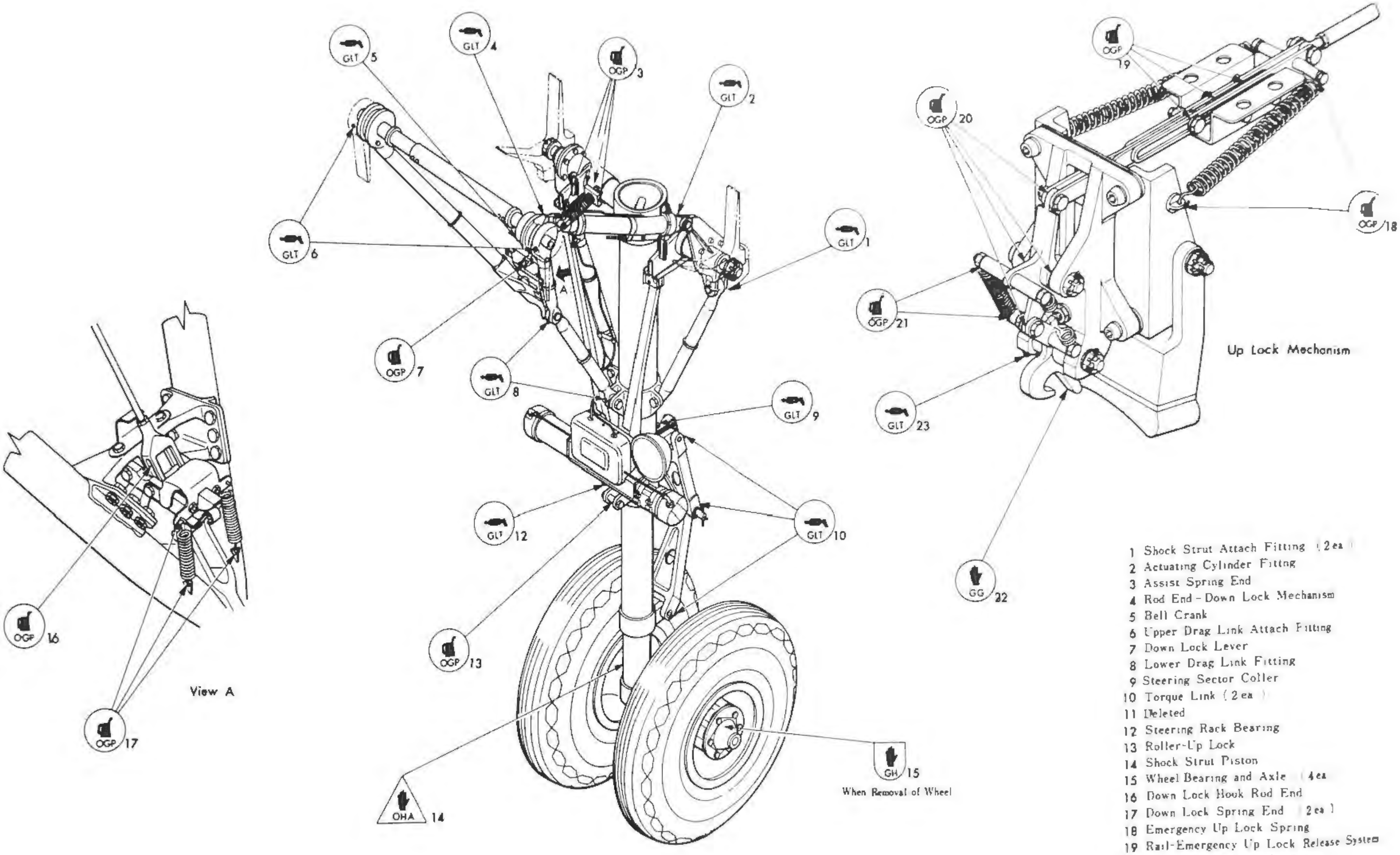
Figure 15–1



1	Screw Jack (4ea)
2	Chain Coupling and Slide Type Coupling (4ea)
3	Flap Drive Torque Tube Swing Stopper
4	Rail-Flap (6ea)
5	Chain Coupling and Slide Type Coupling (2ea)
6	Transmission and Cam Disk Running Gear
7	Stopper System Screw
8	Stopper System Shaft
9	Stopper System Chain
10	Trime Tab Actuator Shaft
11	Actuator and Idler (2ea)
12	Rod (Spring Tab Mechanism)
13	Spring (Spring Tab Mechanism)
14	Space Between Bush and Acme Screw

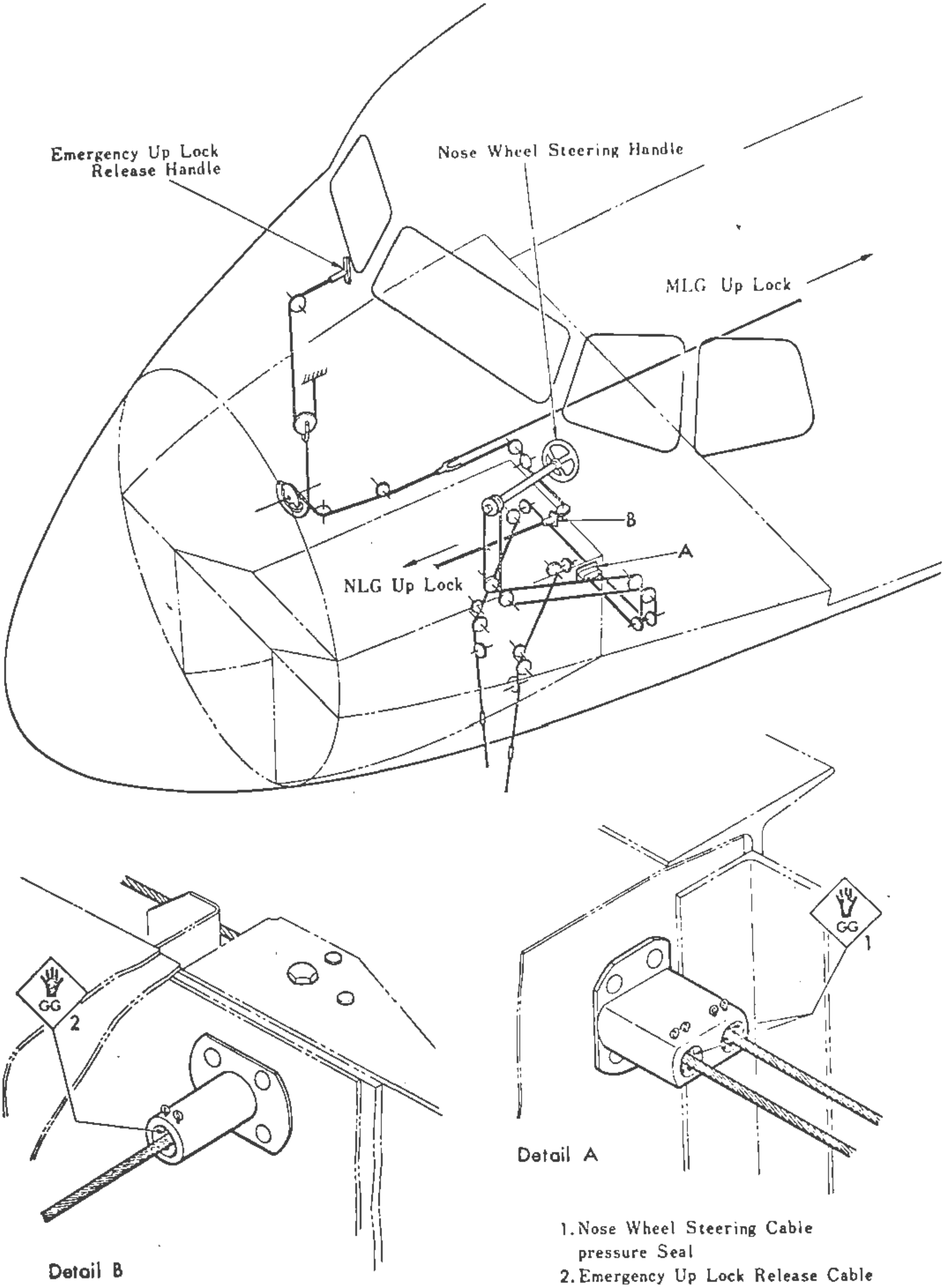
Lubrication-Flap Drive & Aileron Control

Figure 16-49



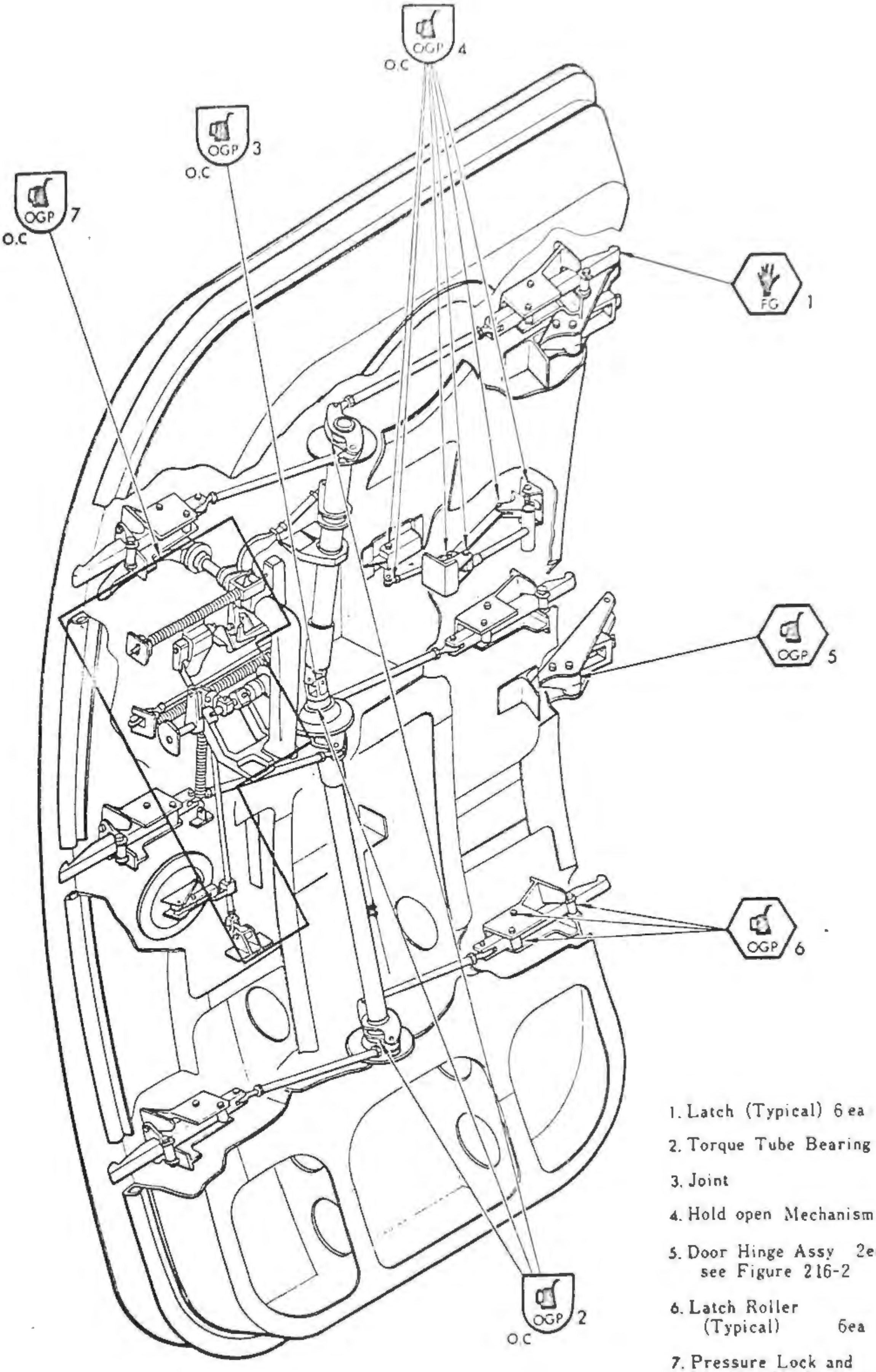
1 Shock Strut Attach Fitting (2 ea)
2 Actuating Cylinder Fitting
3 Assist Spring End
4 Rod End - Down Lock Mechanism
5 Bell Crank
6 Upper Drag Link Attach Fitting
7 Down Lock Lever
8 Lower Drag Link Fitting
9 Steering Sector Coller
10 Torque Link (2 ea)
11 Deleted
12 Steering Rack Bearing
13 Roller-Up Lock
14 Shock Strut Piston
15 Wheel Bearing and Axle (4 ea)
16 Down Lock Hook Rod End
17 Down Lock Spring End (2 ea)
18 Emergency Up Lock Spring
19 Rail-Emergency Up Lock Release System
20 Emergency Up Lock Linkage
21 Emergency Up Lock Spring End (2 ea)
22 Up Lock Hook
23 Up Lock Bracket Fitting (2 ea)

Lubrication-Nose Landing Gear
Figure 16-54



1. Nose Wheel Steering Cable pressure Seal
2. Emergency Up Lock Release Cable pressure Seal

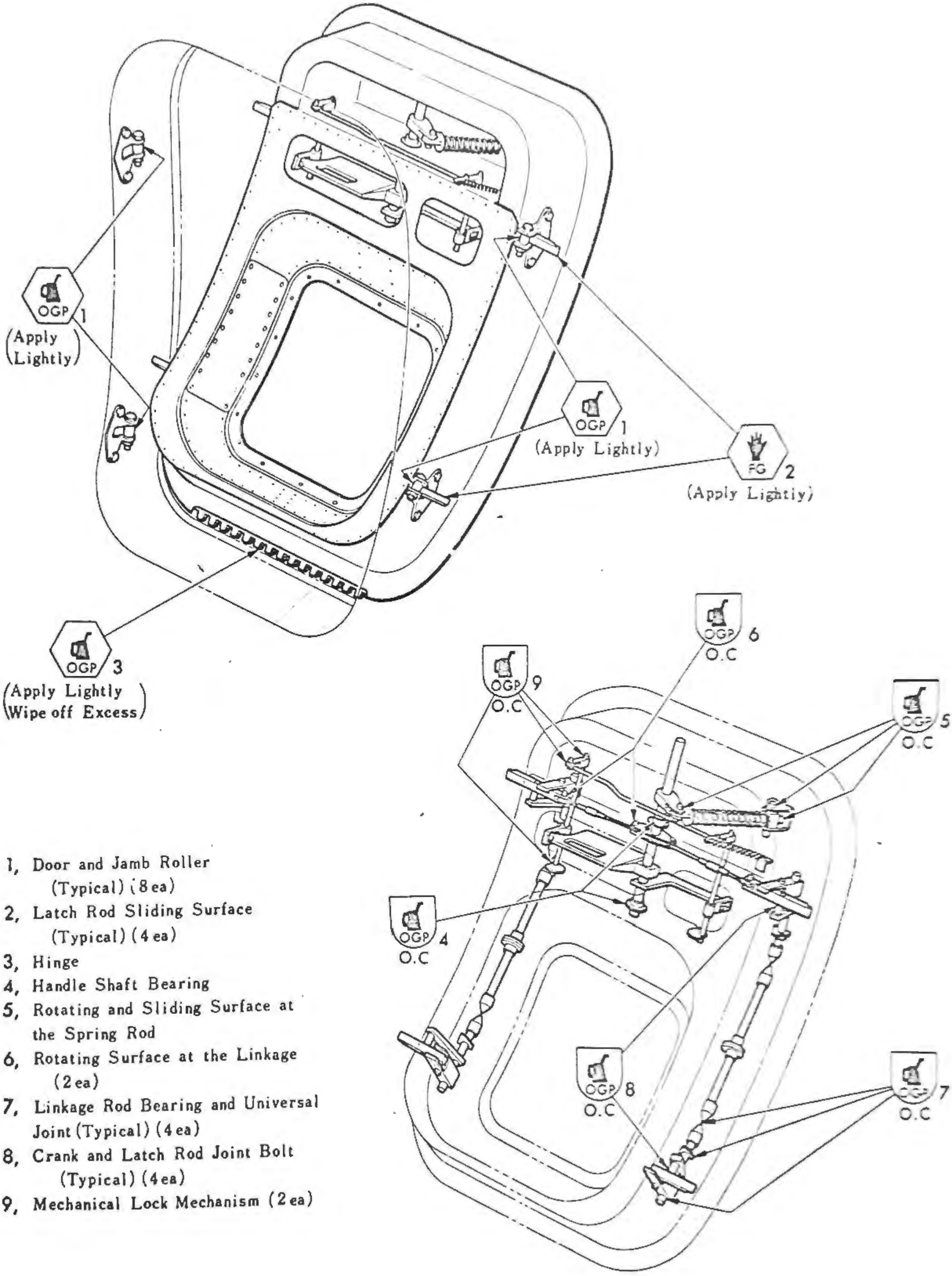
Lubrication-Nose Landing Gear Well
Figure 16–55



1. Latch (Typical) 6 ea
2. Torque Tube Bearing
3. Joint
4. Hold open Mechanism
5. Door Hinge Assy 2ea see Figure 216-2
6. Latch Roller (Typical) 6ea
7. Pressure Lock and Latching Mechanism See Figure 216-2

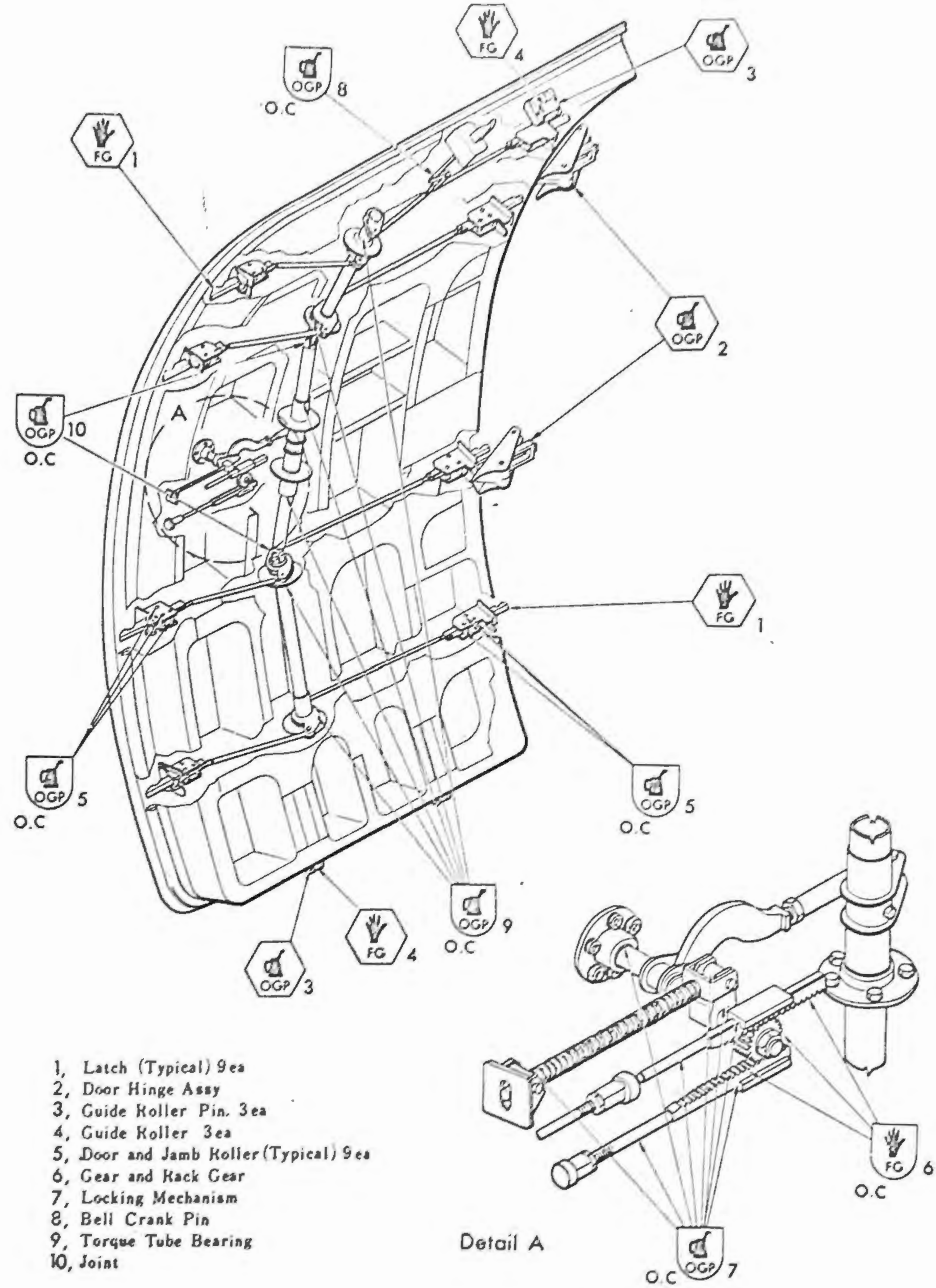
Lubrication-Galley Service Door, Front Cargo Door and After Cargo Door

Figure 16–59



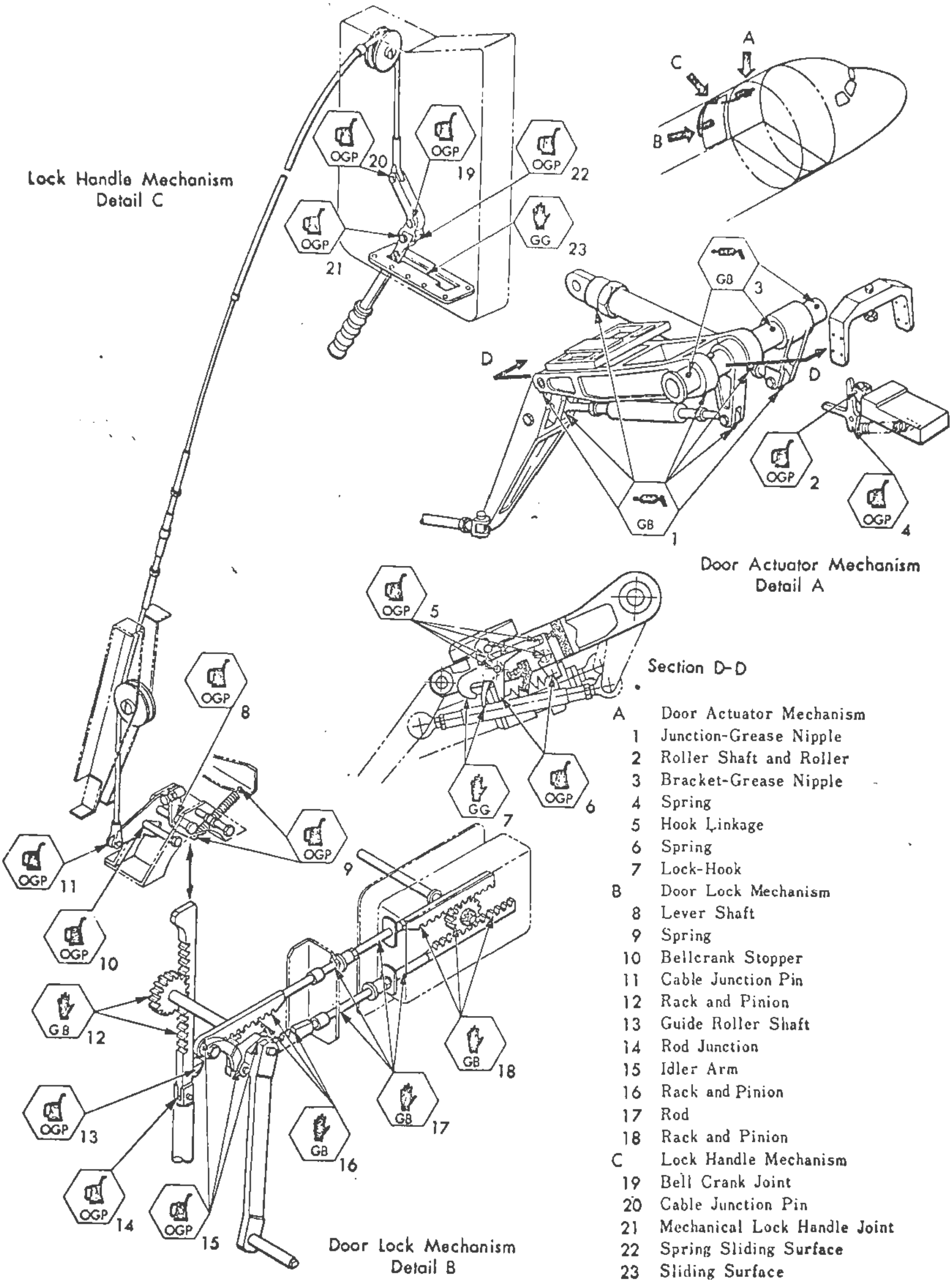
1, Door and Jamb Roller (Typical) (8 ea)
2, Latch Rod Sliding Surface (Typical) (4 ea)
3, Hinge
4, Handle Shaft Bearing
5, Rotating and Sliding Surface at the Spring Rod
6, Rotating Surface at the Linkage (2 ea)
7, Linkage Rod Bearing and Universal Joint (Typical) (4 ea)
8, Crank and Latch Rod Joint Bolt (Typical) (4 ea)
9, Mechanical Lock Mechanism (2 ea)

Lubrication – Emergency Exit Door
Figure 16–61



1, Latch (Typical) 9ea
2, Door Hinge Assy
3, Guide Roller Pin. 3ea
4, Guide Roller 3ea
5, Door and Jamb Roller (Typical) 9ea
6, Gear and Rack Gear
7, Locking Mechanism
8, Bell Crank Pin
9, Torque Tube Bearing
10, Joint

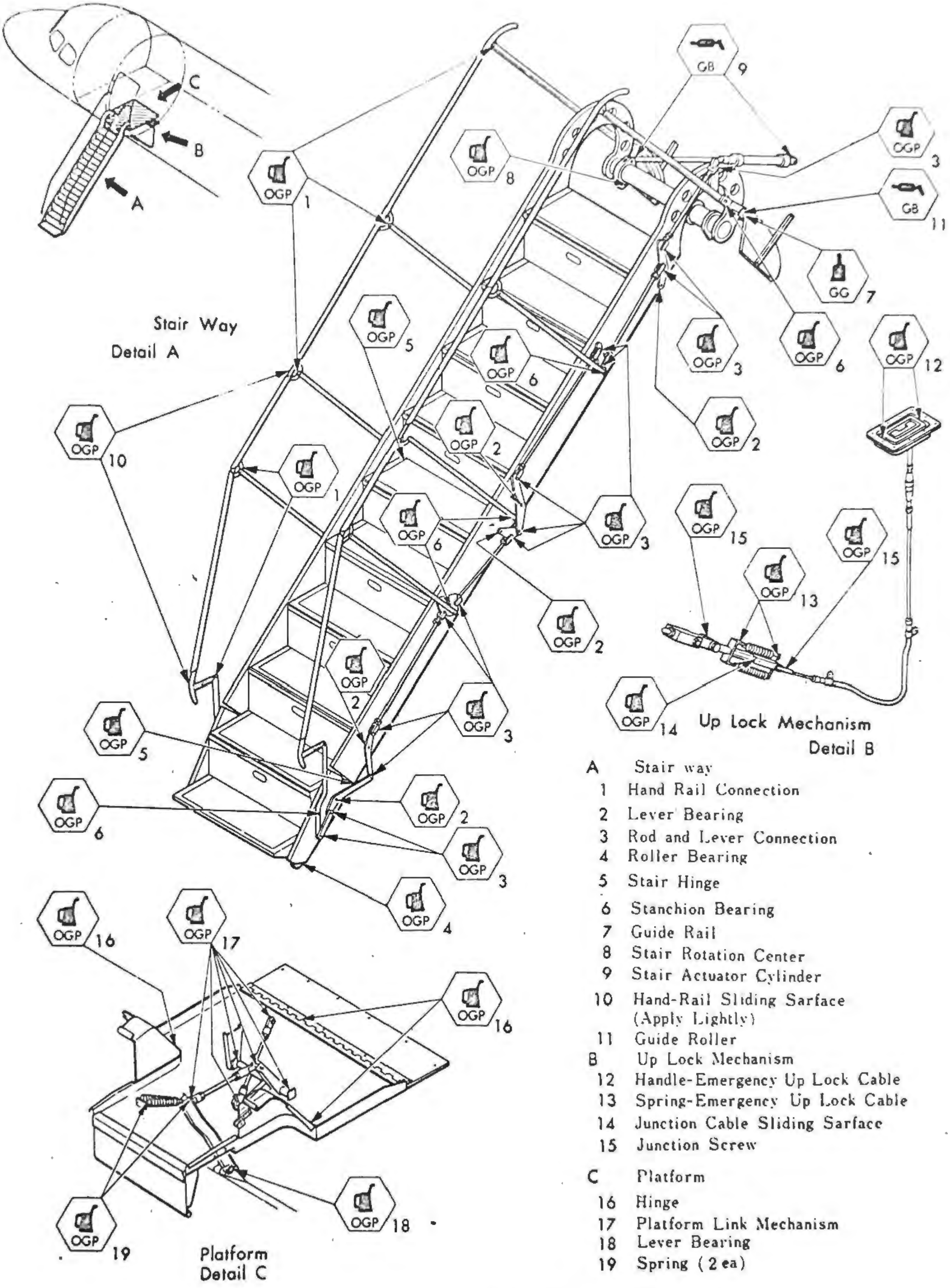
Lubrication – Cabin Entrance Door
Figure 16–65



A	Door Actuator Mechanism
1	Junction-Grease Nipple
2	Roller Shaft and Roller
3	Bracket-Grease Nipple
4	Spring
5	Hook Linkage
6	Spring
7	Lock-Hook
B	Door Lock Mechanism
8	Lever Shaft
9	Spring
10	Bellcrank Stopper
11	Cable Junction Pin
12	Rack and Pinion
13	Guide Roller Shaft
14	Rod Junction
15	Idler Arm
16	Rack and Pinion
17	Rod
18	Rack and Pinion
C	Lock Handle Mechanism
19	Bell Crank Joint
20	Cable Junction Pin
21	Mechanical Lock Handle Joint
22	Spring Sliding Surface
23	Sliding Surface

Lubrication-Cabin Entrance Door

Figure 16–66



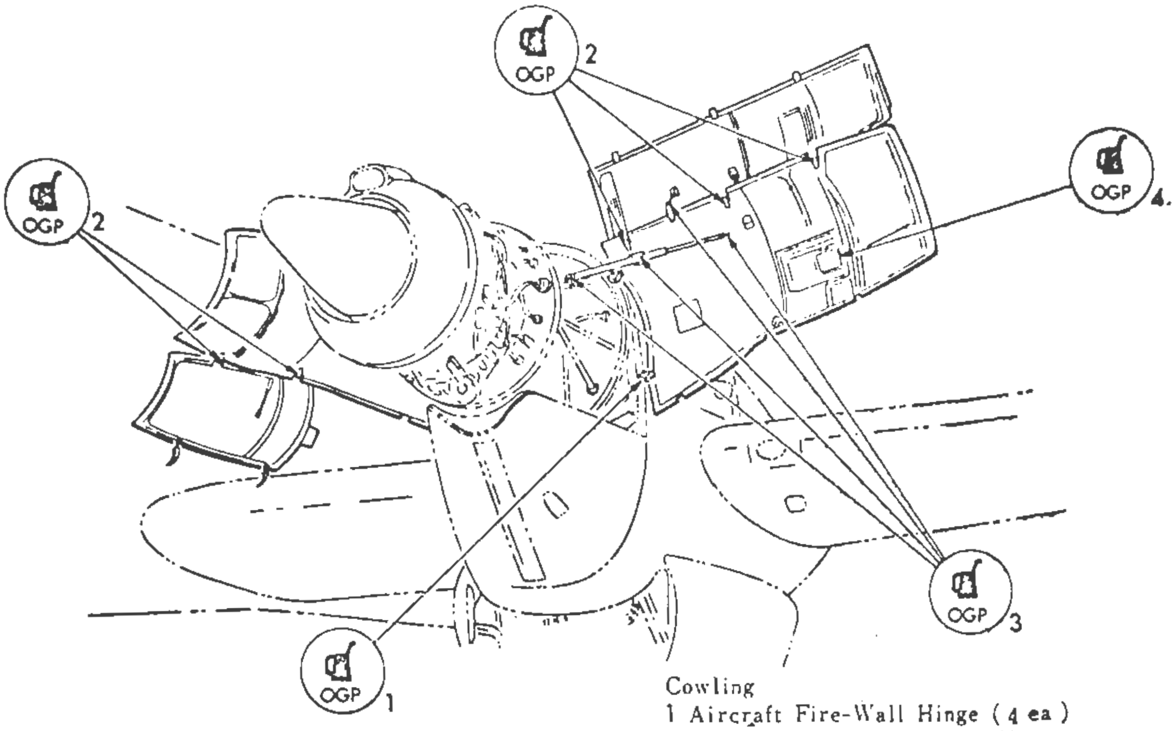
Stair Way
Detail A

Up Lock Mechanism
Detail B

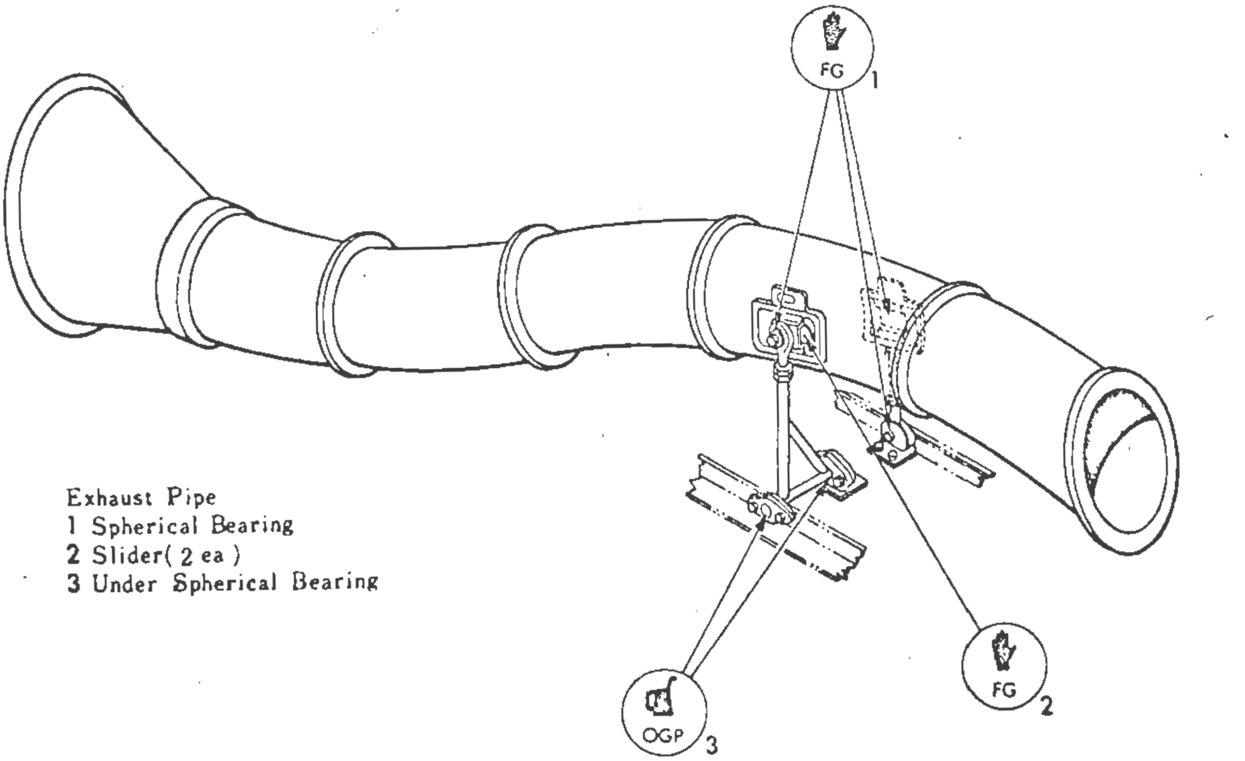
Platform
Detail C

A	Stair way
1	Hand Rail Connection
2	Lever Bearing
3	Rod and Lever Connection
4	Roller Bearing
5	Stair Hinge
6	Stanchion Bearing
7	Guide Rail
8	Stair Rotation Center
9	Stair Actuator Cylinder
10	Hand-Rail Sliding Sarface (Apply Lightly)
11	Guide Roller
B	Up Lock Mechanism
12	Handle-Emergency Up Lock Cable
13	Spring-Emergency Up Lock Cable
14	Junction Cable Sliding Sarface
15	Junction Screw
C	Platform
16	Hinge
17	Platform Link Mechanism
18	Lever Bearing
19	Spring (2 ea)

Lubrication-Stair Way Mechanism
Figure 16–67



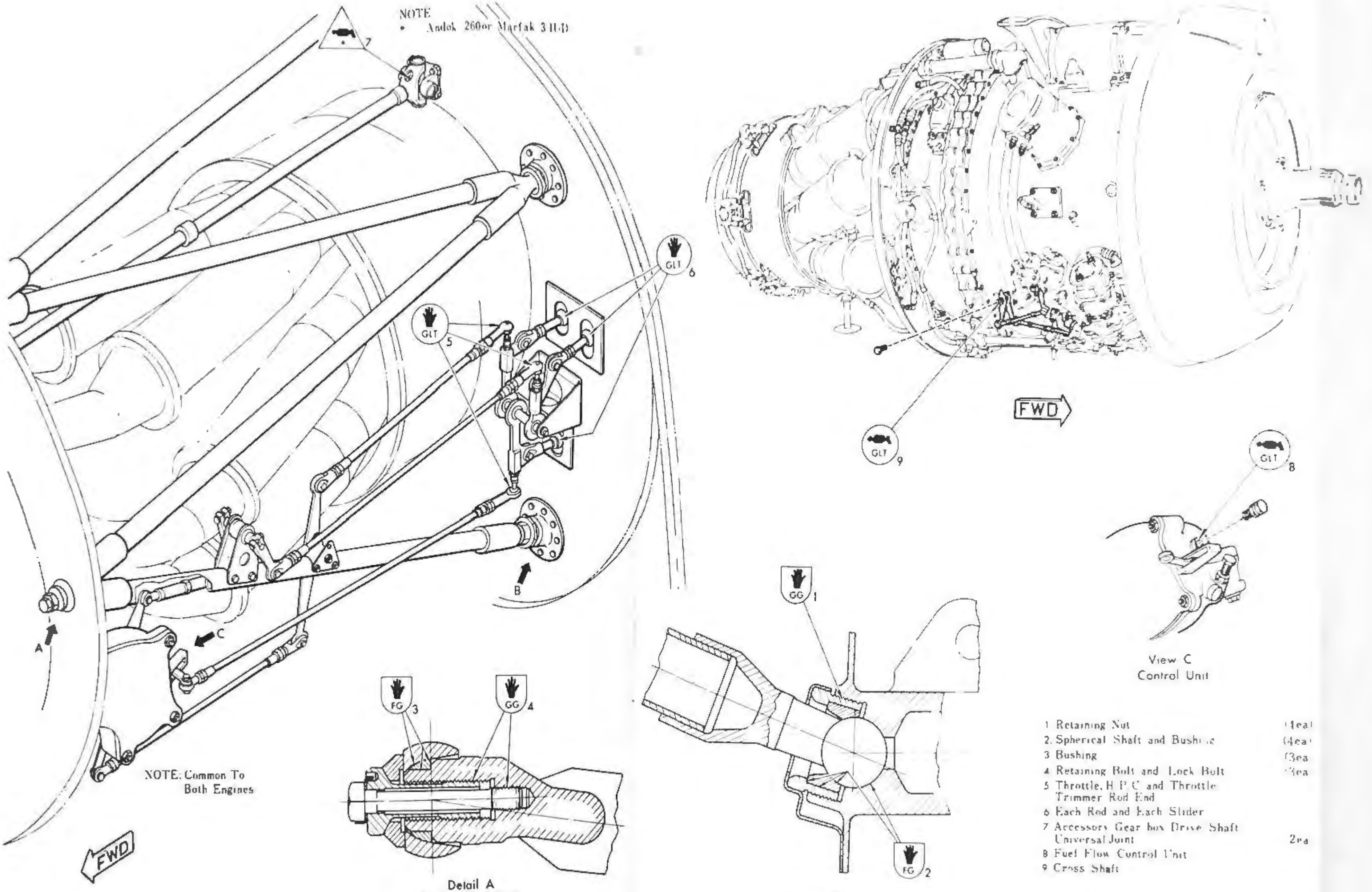
Cowling
1 Aircraft Fire-Wall Hinge (4 ea)
2 Upper and Lower Cowling Hinge
3 Cowling Support (2 ea)
4 Fire Access Panel (2 ea)



Exhaust Pipe
1 Spherical Bearing
2 Slider (2 ea)
3 Under Spherical Bearing

Lubrication-Cowling and Exhaust Pipe

Figure 16–68



NOTE
- Andok 260or Marfak 3 H-D

NOTE: Common To Both Engines

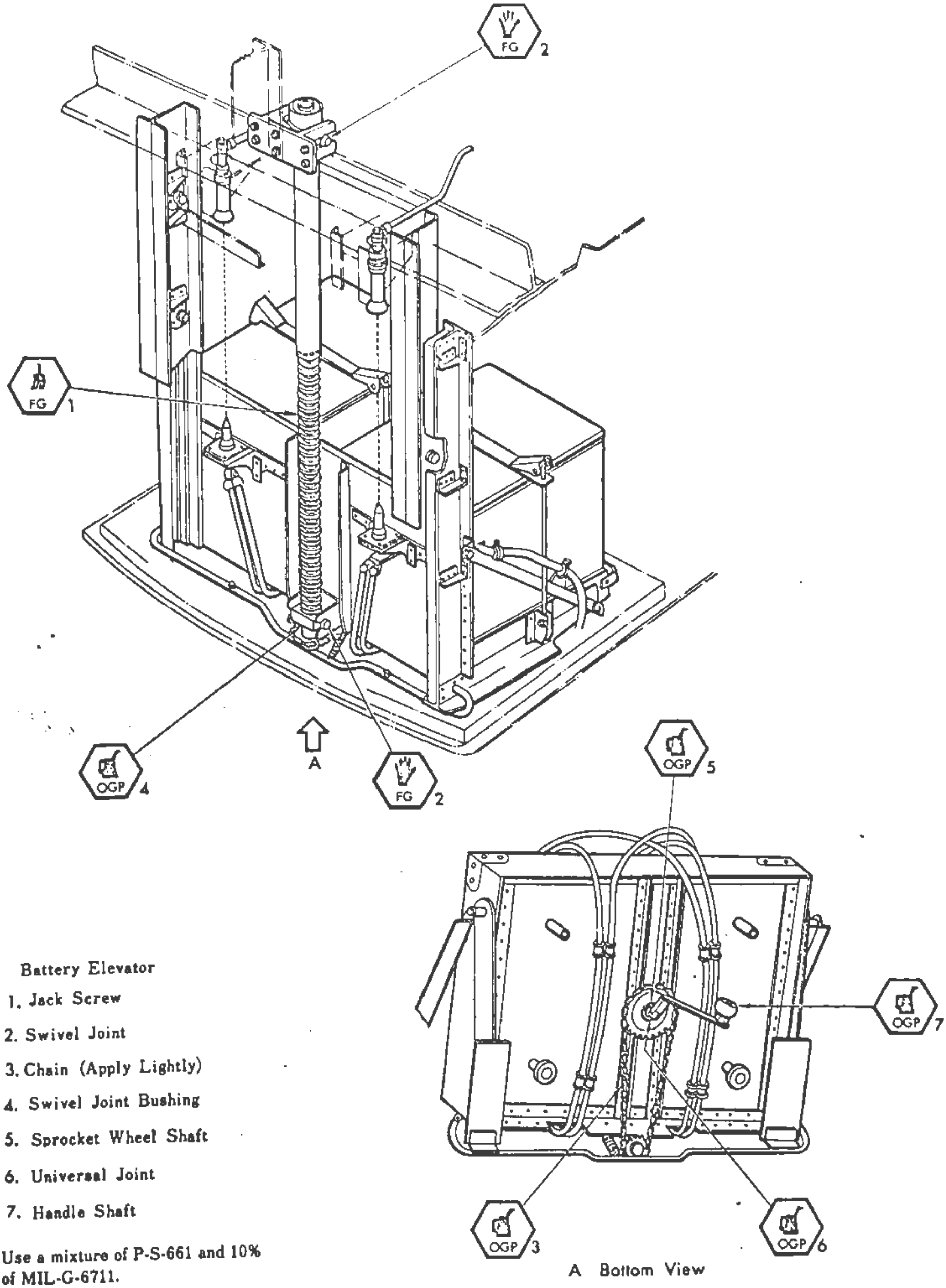
Detail A
Engine Mountings
NOTE: From 1 to 4, at Engine Removal

Detail B
Engine Mounting Installation

View C
Control Unit

1 Retaining Nut	(4ea)
2. Spherical Shaft and Bushing	(4ea)
3 Bushing	(3ea
4 Retaining Bolt and Lock Bolt	(3ea
5 Throttle, H P C and Throttle Trimmer Rod End	
6 Each Rod and Each Slider	
7 Accessory Gear box Drive Shaft Universal Joint	2ea
8 Fuel Flow Control Unit	
9 Cross Shaft	

Lubrication-Engine Mounting and Control
Figure 16–69

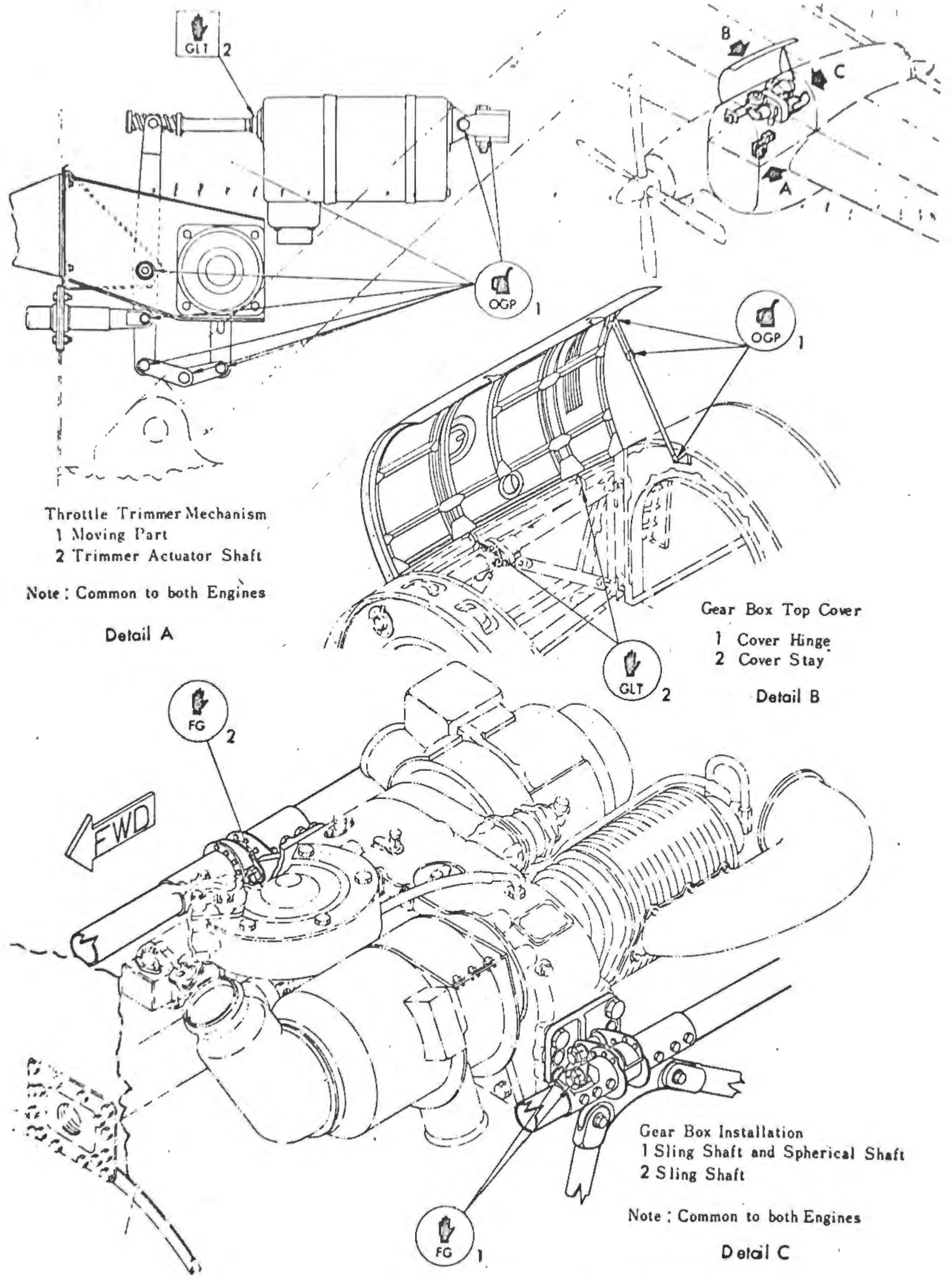


Battery Elevator

1. Jack Screw
2. Swivel Joint
3. Chain (Apply Lightly)
4. Swivel Joint Bushing
5. Sprocket Wheel Shaft
6. Universal Joint
7. Handle Shaft

Use a mixture of P-S-661 and 10% of MIL-G-6711.

Lubrication-Battery Elevator
Figure 16–70



Throttle Trimmer Mechanism
1 Moving Part
2 Trimmer Actuator Shaft

Note : Common to both Engines

Detail A

Gear Box Top Cover
1 Cover Hinge
2 Cover Stay

Detail B

Gear Box Installation
1 Sling Shaft and Spherical Shaft
2 Sling Shaft

Note : Common to both Engines

Detail C

Lubrication-Throttle Trimmer Mechanism and Gear Box Installation
Figure 16–71